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THE GEOGRAPHICAL JOURNAL

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NOTICES

SESSION 1927–1928.

MEETINGS in the ÆOLIAN HALL, 135, New Bond Street, W.1, at EIGHT-THIRTY p.m.

Monday, Nov. 7 A Recent Journey in East Greenland . . . . . Dr. Lauge Koch

,, Nov. 21 The Blue Nile . . . . . Maj. R. E. Cheesman (Read in his absence by Col. H. S. L. Winterbotham)

,, Dec. 5 Lubaantun . . . . . Maj. J. C. Cooper Clark and Mr. Geoffrey Laws

,, Dec. 19 Johore in 1926 . . . . . Capt. S. W. Kirby

,, Jan. 9 The Nanda Devi Problem . . Dr. T. G. Longstaff

MEETINGS in the MAP ROOM, Lowther Lodge, at FIVE p.m.

Monday, Nov. 14 The Triangulation of Africa . . . . . Col. H. S. L. Winterbotham

,, Dec. 12 Gravity Survey by Submarine via Panama to Java . Dr. Vening Meinesz

,, Jan. 16 The Physical Geography of South-East Arabia . . Mr. G. M. Lees

EXHIBITION ROOM. The attention of Fellows is called to the water-colour sketches of Johore, Borneo, and Sarawak by Mr. J. C. T. Willis, R.E., now exhibited.

THE SOCIETY'S HOUSE. The House is open on week-days from 10 a.m. to 6 p.m.

By Order of the Council,
ARTHUR R. HINKS,
Secretary.

The Geographical Journal

Vol. LXX No. 5 November 1927

ALEXANDER'S CAMPAIGN ON THE INDIAN NORTH-WEST FRONTIER

NOTES FROM EXPLORATIONS BETWEEN UPPER SWĀT AND THE INDUS

Sir Aurel Stein, K.C.I.E., F.B.A., Indian Archæological Survey

Folding map following p. 512.

MY recent tour of archæological and geographical exploration across the Indian North-West Frontier led me through a fascinating region, hitherto inaccessible for the most part, upon which my eyes had been fixed for fully thirty years. The hill tracts stretching northward beyond the Peshawar border owe their special antiquarian and historical interest to two facts. The fertile valleys drained by the Swāt river, together with the tribal territory of Bunēr south-eastward, had long ago been recognized as corresponding to the ancient *Udyāna*,* a country famous in Buddhist tradition. The early worship and culture which once flourished there were known to have left their traces behind in numerous as yet unsurveyed ruins. But what invests this whole region with an additional historical interest, and one likely to appeal to a wider public, anyhow in the West, is the fact that it must have been the scene of important events in that arduous campaign which brought Alexander the Great from the foot of the snowy Hindukush to the Indus and preceded his triumphant invasion of the Punjab. The present account of the explorations carried out by me on this ground from March to May 1926 will be restricted in the main to what indications I succeeded in tracing of the Macedonian conqueror's passage.

Before, however, I proceed to record these and kindred antiquarian observations we may pass a rapid glance over the general geographical features of this region. Its central and most important part is formed

* For the sake of convenience we may continue to use this long-accepted Sanskrit form of the name, though the researches of Professor F W. Thomas and M. Sylvain Lévi have proved the true form of the name, as attested by Buddhist Sanskrit texts, to be *Uḍḍiyāna* or *Oḍḍiyāna*; cf. *J.R.A.S.*, 1905, p. 461; *Journal Asiatique*, 1915, I, pp. 105 *sqq.*, and below, p. 436.

by the territory of Swāt. The river which drains the whole of it and from which it takes its name (a very ancient one, mentioned already in the Rigveda as *Suvāstu* and by Megasthenes as Σόαστος), descends from the high ice-crowned range between Chitrāl and the headwaters of the Gilgit river and joins the Kābul river not far from Peshawar. The Swāt valley is quite alpine in its upper portion where I saw it flanked by magnificent glacier-clad peaks rising close to 19,000 feet in height. But below the hill tract known as Tōrwāl it widens greatly, and for a distance of over 60 miles comprises a wide expanse of fertile plain on either side, easily irrigated and used largely for rice cultivation.

Bold spurs descending to the river from the watershed range in the south divide this open and rich portion of the main Swāt valley at two points. Down to the barrier formed by the Shamēlai spur above the town of Mingaora the valley continues the almost due north-south direction it follows in the mountains. From there it turns south-west to where the precipitous Landakai ridge forms a natural dividing line between Upper and Lower Swāt. Thence the valley takes a more westerly course, still retaining its fertile riverine plain for some 20 miles farther. But beyond, from above the confluence with the Panjkōra, it contracts rapidly. Finally it is through narrow and in parts almost impassable gorges that the river forces its way down to the great open plain of the Peshawar valley. Together with the numerous large side valleys on both sides, Swāt is a territory singularly favoured by nature and of great potential wealth. Occupied now by Pathān tribes, comparatively recent invaders, Swāt has for the last four centuries or more suffered greatly from a state of chronic disorder such as seems endemic in that race when left uncontrolled by some strong power.

South of the lower part of Swāt lies the open plain of the Peshawar valley, the ancient *Gandhāra*, drained by the Kābul river and now as of old the most important district on the North-West Frontier. It has always served as a passage wide open for invaders of India from the north-west. Where the barren but picturesque hill range dividing the Peshawar valley from Swāt rises higher and takes a decided turn to the north-east, it throws off a branch at right angles which runs down to the Indus and encircles the territory of Bunēr. Less extensive and less fertile than Swāt and accessible from it by a number of comparatively easy passes, Bunēr seems always to have shared the political fate of its northern neighbour. As we follow the main range above the left bank of the Swāt river farther up, its height steadily increases and its character as the great divide between the Swāt river and the Indus becomes more defined.

The valleys which run down from this watershed towards the Indus, though not large, are still comparatively open and fertile and hold now a Pathān population closely allied with that of Swāt. But above the mouth of the Ghōrband river the Indus valley rapidly contracts

into a succession of narrow and very difficult gorges comprehensively designated as the Indus Kohistān. The small independent communities of Dard speech which are settled there, together with those to be found in Tōrwāl and elsewhere on the headwaters of the Swāt river, may safely be recognized as a remnant of that pre-Muhammadan population which once held Swāt and the adjacent tracts, and which the Pathān invasion has driven back farther into the mountains or gradually absorbed. The great height of the snowy range separating this portion of the Indus valley from the Swāt river drainage sufficiently explains why there is no need to pursue our rapid survey in this direction further.

Turning now to the west we find Upper Swāt bordered by the territory known as Dīr and drained by branches of the Panjkōra; this joins the Swāt river before the latter emerges on the plain of the Peshawar valley. The tract on the northernmost headwaters of the Panjkōra, in respect of its forests, its ample grazing-grounds and its remnant of Dard-speaking hillmen, resembles the corresponding portion of Upper Swāt. Here too the land-owning population in the lower valleys is Pathān. But neither in size nor in natural resources can Dīr bear comparison with Swāt, and its political importance is due solely to the fact that through it leads the direct route connecting Chitrāl and its Hindukush passes with the North-West Frontier. Crossing the Panjkōra to the west the Pathān tribal tract of Bājauṛ is reached. Considerable as its area of arable land is, Bājauṛ lacks the advantages of abundant irrigation such as Swāt derives from its large snow-fed river; otherwise, too, the territory is far less favoured by nature. To the west there stretches the Hindurāj range forming the watershed between Bājauṛ and the large valley of the Kūnar river, included in the Afghān kingdom. Here we find again great natural resources assured by the abundance of water which the Kūnar or Chitrāl river carries down from the snow and ice-clad heights of the main Hindukush range. With the alpine tracts of Kāfiristān which lie between the latter and the Kūnar valley we are not concerned here.

My first chance of visiting at least a small portion of this wide region came after the Chitrāl campaign of 1895 had resulted in the military occupation of the Malakand pass leading into Lower Swāt and of the fort of Chakdara which guards the passage of the Swāt river on the route towards Dīr and Chitrāl. During short Christmas holidays of 1896 and 1897 I was enabled through the help of the late Colonel (subsequently Sir Harold) Deane, the first Political Agent for Dīr, Swāt, and Chitrāl, to pay rapid visits to such ruins of Buddhist shrines and other ancient remains as are situated within that comparatively small portion of tribal territory in Lower Swāt which had passed under British protection. It was largely due to the support of the same kind friend that in January 1898 I was permitted to accompany the field force which under the command of General Sir Bindon Blood carried out a punitive expedition

into Bunēr, and to use this opportunity, short as it was, for an archæological survey of the chief ancient sites traceable in that territory.*

Military considerations did not permit my being allowed on that occasion to visit, as I had eagerly hoped, Mount Mahāban in the south-eastern extremity of Bunēr. There a conjecture, first put forward by General Abbott in 1854 and since widely accepted, had proposed to locate the rock stronghold of Aornos, the scene of the most famous exploit in Alexander's campaign west of the Indus. But my eager wish to test this location on the spot—it was based solely on observations made from a great distance—found fulfilment in the autumn of 1904. Through arrangements with the neighbouring tribes Sir Harold Deane, that great Warden of the Marches, then raised to the Chief Commissionership of the newly created North-West Frontier Province, made it possible for me as the first European to visit and survey the heights of Mahāban. Careful examination of the topographical features of this conspicuous massif, overlooking the plains between the Kābul river and Indus, proved that they could not be reconciled with essential details recorded in the Greek historians' account of that celebrated military feat.† It was a result purely negative. But the state of "tribal politics" then prevailing precluded any attempt being made to visit the ground higher up near the right bank of the Indus, where, as various considerations suggested to me, the true site of Aornos might possibly have to be looked for.

Conditions of chronic disturbance among the Pathān tribes along this portion of the North-West Frontier, together with deep-rooted fanatical distrust of Europeans and all their doings, continued to bar access to Upper Swāt and the adjacent tracts for close on two decades longer. But on the start of my second expedition to Chinese Turkestān, in 1906, I was able to take my way towards Chitrāl and the Pāmīrs by the British-controlled road past Malakand, Chakdara, and Dīr. This gave me a chance of crossing the ground between the Panjkōra and Swāt which must have seen the Macedonian columns pass by. The record of the impressions then received gave me subsequently an opportunity of reviewing in some detail such notices of ancient Swāt and its *topographia sacra* as the accounts of early Chinese pilgrims visiting its Buddhist sites have fortunately handed down to us.‡

It was not until after my return from my third Central-Asian journey (1913–16), and after the strain experienced on the Frontier during the war and in the years immediately following had passed by, that I was able to make a fresh attempt to reach the ground on the Swāt river and the Indus which had so far remained closed to antiquarian research.

* See Stein, 'Detailed Report of an Archæological Tour with the Bunēr Field Force' (Lahore, 1898); reprinted in *Indian Antiquary*, January-March 1899.

† See Stein, 'Report of Archæological Survey Work in the N.W. Frontier Province and Baluchistan' (1905), pp. 19–31.

‡ Cf. Stein, 'Serindia,' i. pp. 1–5.

Guided by such local information as I had been able to gather in December 1921, on a rapid tour along the Hazāra border where it runs near the left bank of the Indus, I approached Sir John Maffey, then Chief Commissioner of the North-West Frontier Province, with a view to being enabled to visit the tribal territory on the opposite side of the river. There a big spur descending from the Swāt–Indus watershed range approximately faces the Black Mountain, the scene of more than one hard-fought Frontier expedition. My special attention had been first called to that ground by my lamented friend Colonel R. A. Wauhope, R.E., of the Survey of India, who on two of those expeditions, in 1888 and 1891–2, had sighted it across the river from the Black Mountain side, and who thought that a likely location of Aornos might there be possibly looked for.

My hope of being allowed to test this suggestion by actual exploration was frustrated for some time by the political situation, more than usually disturbed, which then had arisen in that transborder region. Aggravated dissension between the several tribal sections of Upper Swāt had weakened whatever authority the Miānguls, descendants of that famous saint, the Ākhund of Swāt, and inheritors of a kind of spiritual authority in the land, were able to exercise. The opportunity offered by this state of internal division was being seized by ambitious neighbouring chiefs to extend their territories at the expense of Swāt. While the Nawāb of Dīr was gradually occupying most of the rich tracts on the right bank of the river from the Swāt Kohistān downwards, the Nawāb of Amb and Darband on the Indus was invading Bunēr and threatening to absorb the rest of the main valley of Swāt from the south-east. Fortunately for the modern destinies of ancient Udyāna and incidentally also for my desired explorations, the few years immediately following saw the rise to power in Swāt of a very capable ruler in the person of Miāngul Gul Shāhzāda, the elder of the two grandsons of the great Ākhund. He succeeded in driving out both invaders after a prolonged struggle in the course of which his younger brother was killed. Having thus become undisputed master of Upper Swāt he was soon able to extend his sway also to Bunēr, to the lower portion of the Swāt Kohistān, and to the valleys of Ghōrband, Kāna, Chakēsar, and Pūran between the Swāt watershed and the Indus. All these territories are closely linked to Swāt by geographical relations and history.

The peaceful consolidation of the large "kingdom" thus created during the last four years is being greatly facilitated by the close and satisfactory relations which the Miāngul, or "Bādshāh" as he is now universally known to his people, has wisely fostered with the administration of the North-West Frontier Province. It was solely through this fortunate concatenation of events that the realization of my long-cherished plan of exploration became possible, and to an extent far greater than I had originally ventured to hope for.

Under the instructions kindly given by the Hon'ble Sir Norman Bolton, Chief Commissioner of the North-West Frontier Province, to whom I had re-submitted my proposal from England in the summer of 1925, my old and ever-helpful friend Colonel E. H. S. James, then Political Agent for Dīr, Swāt and Chitrāl, was able to secure the ruler of Swāt's approval for my intended visit to his territory and for the researches I was anxious to effect there. The truly enlightened spirit of the ruler induced him to use all resources at his disposal to facilitate my labours and to assure free and safe movement on ground hitherto inaccessible to Europeans, It thus became possible for me to extend my explorations over most of his territory instead of the comparatively small area to which my original request had applied. In the same way he readily agreed to my archæological investigations being accompanied also by proper topographical surveys such as they necessarily called for on ground but imperfectly known before from native route reports and the like.

It was no small privilege for me to be enabled to spend two and a half months of last spring over antiquarian and geographical exploration in a region which presents exceptional interest to the historical student, and which for the most part had never been visited by a European since ancient times. For this and for all the advantages assured to my efforts I must record here my sincerest gratitude in the first place to the ruler of Swāt. I feel that I owe warm thanks also to those on the British side who gave all needful help for the execution of my plan, after its acceptance by the Miāngul had been secured; to the Government of India in the Archæological Department, which on Sir John Marshall's recommendation sanctioned my employment on the proposed tour and provided a grant of Rs.2000 for its expenses; to Colonel W. J. Keen, who, as Officiating Chief Commissioner of the North-West Frontier Province, encouraged me greatly by his kind personal interest in the enterprise. From Mr. H. J. Metcalfe, I.C.S., Political Agent, Dīr, Swāt, and Chitrāl, I received much useful advice and constant proofs of friendly care both before and after my start from his headquarters on the Malakand. The Survey of India Department once again offered me very valuable help by providing a fully trained and extremely hardworking assistant for topographical work in the person of Surveyor Tōrabāz Khān. In the course of our travel he succeeded in mapping a total area of some 1800 square miles on the scale of 2 miles to the inch. The accompanying sketch-map embodies these surveys. Nor should I omit to mention here the devoted services in connection with practical archæological tasks which were rendered by Naik Abdul Ghafūr, the capable "handyman" deputed with me from K.G.O. Bengal Sappers and Miners.

Before I proceed to set forth those archæological and topographical indications which my recent explorations have enabled me to gather concerning particular points of Alexander's campaign in the region now controlled by the ruler of Swāt, it will be convenient rapidly to

review the main historical data to be gathered about that campaign from the available classical records. These notices have been often discussed, and as a clear and critical account of them is readily accessible in the late Mr. Vincent Smith's 'Early History of India,' our review may be brief.* Alexander in the spring of 327 B.C. crossed the Hindukush from Bactria towards the Kōh-i-dāmān above Kābul. There he strengthened the hold he had secured upon this part of the present Afghanistan two years before, and then set out for his Indian campaign. There can be no doubt that as far as the country west of the Indus was concerned this enterprise meant, in theory at least, but a reassertion of the sovereignty of that Persian Empire to which he claimed succession and which down to the last Achæmenidian 'King of Kings' had its satrapies right up to the Indus. At Nikaia, a place not yet exactly determined, in the upper valley of the Kābul river, he divided his army. One large force was to move to the tract of Peukelaotis (Sanskrit *Pushkalāvatī*, safely located near Chārsadda, north-east of Peshawar) and to effect the submission of the country as far as the Indus. The other corps was led by Alexander himself into the hill country to the north of the Kābul river, obviously with a view to securing the flank of his main line of communication along it.

The details of the route followed on Alexander's operations against various towns by "the river called Khoes" and against the tribe of the Aspasioi cannot be determined. But it may be considered as certain that they took him for a considerable distance up the large and populous valley of the Kūnar river.† Geographical facts make it equally clear that the scene of subsequent operations, when he had crossed the mountains and moved east,‡ was the present Bājaur. This is rendered quite certain by the mention of the river Guraios, which had to be passed by the Macedonians before Alexander could lead them into the country of the Assakēnoi; for the identity of the Guraios with the Panjkōra, coming from the mountains of Dīr and flowing east of Bājaur before it joins the Swāt river, is well established.§ No definite attempt can be made to identify the localities mentioned west of the Guraios, as long as Bājaur remains inaccessible for research.

With the passage of the Guraios or Panjkōra we are brought close to the territory which directly concerns us here; for it has long ago been recognized that the country of the powerful nation of the Assakēnoi,

* See 2nd edition, pp. 45 *sqq*. Full translations of the notices furnished by Arrian, Diodorus, Curtius, and some minor sources are to be found in M'Crindle, 'The Invasion of India by Alexander the Great' (1893).

† See my remarks on the importance of the Kūnar valley and the indications pointing to its having been the scene of those operations, in 'Serindia,' I, p. 3.

‡ Cf. Arrian, 'Anabasis,' IV. xxiv.

§ See 'Serindia,' I, p. 2, note 2. The difficulty of the passage across the Guraios which Arrian, IV. xxv., specially comments upon, is illustrated by the experience of the British forces when operating against Bājaur from the Swāt side and across the Panjkōra in 1905 and 1907.

the invasion of which was begun after crossing the river, could be no other than Swāt. The numerical strength of the nation and the size of the territory held by it are sufficiently indicated by the numbers recorded by Arrian for the army ("2000 cavalry and more than 30,000 infantry, besides 30 elephants") which had gathered to oppose Alexander's advance. Yet we are told that when the barbarians saw Alexander approaching they did not dare to encounter him in the open, and dispersed to their several cities in order to defend them.*

From this and the account of the several sieges which followed the inference seems justified that the Assakēnoi, though a brave race, could not have been addicted to those fierce and very effective methods of fighting which make the present hill tribes along the barren parts of the North-West Frontier so formidable opponents on their own ground. From the superior type of the abundant structural remains still extant in Swāt from early Buddhist times, and from what we know through the Chinese pilgrims' account of the character of its inhabitants at a later period, it may, in fact, be safely concluded that the material civilization and culture prevailing in that region in Alexander's time and for centuries after was far higher than those to be met with there now, or among the semi-barbarous Pathān tribes holding the barren hills from the Mohmand country down to Wazīristān. Nor should it be forgotten that the possession of lands so fertile as those of Swāt, combined with the enfeebling effect of the rice cultivation preponderant in its valleys, tends to have a debilitating influence on the inhabitants. This is apparent even from the present Pathān population, and must have asserted itself also in the case of its earlier occupants.

As regards the ethnography of the region through which Alexander's hill campaign took him, two points may conveniently be noted here That the invaders classed the inhabitants as Indians is certain. This fully agrees with what we know from later records about the Indian character of the civilization and religion which prevailed before the Muhammadan conquest along the whole Kābul river valley from the Hindukush to the Indus. At the same time there is good reason to believe that the languages then spoken in that region and in the adjacent hill tracts, including Swāt, were not Indian, but belonged to that independent branch of Aryan speech, designated as Dard or Dardic, which still has its representatives in the valleys south of the Hindukush from Kāfiristān to Kashmīr. In fact, I have shown elsewhere that the very name *Assakēnoi*, in its relation to the corresponding Sanskrit form of *Aśmaka* as attested among tribal designations of the Indian North-West, bears distinct philological evidence to the Dard speech of those to whom it was applied.†

That the territory held by the Assakēnoi was a large one and com-

* Cf. Arrian, 'Anabasis,' IV. xxv.

† See Stein, 'Serindia,' I, pp. 4 *sq.*

prised the whole of the present Swāt, together probably with Bunēr and the valleys to the north of the latter, is clear; for the operations which were needed for their effective subjugation, extended, as the classical records show, from the Panjkōra to the right bank of the Indus. The accounts given by both Arrian and Curtius of these operations, though recorded in some detail, do not suffice—in the absence of local investigations—to fix with any critical assurance the position of the sites which they mention. Only for the initial stages of Alexander's march through this large territory was definite guidance available, and that supplied by plain geographical facts. It is certain that in ancient times, as at present, the direct route, and the only one of any importance, must have led from the Panjkōra through Talāsh and across the easy saddle of Katgala into the wide open valley which stretches down from Wuch to the Swāt river and to its strategically important crossing now guarded by the fort of Chakdara.

Beyond this the only indication to be derived from geography is the very general one that the several strong places in which the Assakēnoi had taken refuge, and which Alexander successively besieged and captured, are likely to have been situated in the main Swāt valley which at all times just as now must have been the most fertile and populous portion of the territory. Arrian, whose account of Alexander's campaign is throughout the most reliable and avowedly based on a careful examination of sources largely contemporary, distinctly tells us that Alexander "marched first to attack Massaga, which was the greatest city in those parts." The reference made to its chief under the name of Assakēnos shows that Massaga was considered the capital.

Arrian gives a lengthy account of the siege which, after battering engines had been brought up against the walls and the chief killed, ended with the city's capitulation. But he furnishes no clue as to the position of Massaga; nor does the elaborate description recorded by Curtius, VIII. x., of the defences with which both nature and man had provided the city (called by him Mazaga), help us to locate it at present. At none of the sites examined by me have I been able to find topographical features resembling those which this description indicates.* Until further search can be made on the ground, I must content myself with expressing the belief that the site of Massaga may probably have to be looked for farther down in Swāt than has hitherto been supposed. Owing to the great expanse of fertile alluvial soil which is to be found there, Lower Swāt must at all times have been a very populous and rich portion

* "For on the east, an impetuous mountain stream with steep banks on both sides barred approach to the city, while to south and west nature, as if designing to form a rampart, had piled up gigantic rocks, at the base of which lay sloughs and yawning chasms hollowed in the course of ages to vast depths, while a ditch of mighty labour drawn from their extremity continued the line of defence. The city was besides surrounded with a wall 35 stadia in circumference," etc.; cf. M'Crindle, 'Invasion of India,' pp. 194 *sq.*

of the whole valley. Its economic and military importance must have been greatly increased in ancient times, just as it is now, by the ease of direct access from it to the open plain of Gandhāra. It appears to me on various grounds very unlikely that Alexander, having been brought by his route from Bājauṛ and the Panjkōra straight to Lower Swāt, could have carried his operations far up the main valley, as has been supposed,* before he had secured his rear and the direct line of communication with the rest of his army on the lower Kābul river. For this it was necessary first to defeat such resistance as that important lower portion of Swāt was bound to have offered to the invader.

Two points recorded in connection with the capture of Massaga deserve to be briefly noted here. One is the mention made of 7000 Indian mercenaries brought from a distance who shared in the defence of the place, and ultimately after its capitulation made a vain endeavour to regain their homes and in that attempt were exterminated. The employment by a local chief of so large a paid contingent from outside clearly indicates conditions of organized defence wholly different from those with which a modern invader of tribal territories on the North-West Frontier would have to reckon. In the second place attention may well be called to the fact that in spite of the recorded great valour of the defenders, Arrian's account puts the total loss suffered by Alexander in the course of the four days' siege at only twenty-five men. In the cheap price paid for this success we may recognize a proof of the ascendancy which the Macedonian force of highly trained and war-hardened veterans derived, in addition to all other advantages, from the possession of superior armament; for both Arrian and Curtius specially testify to the overmastering effect which the use of the besiegers' war engines, including movable towers and powerful ballistæ, had upon the defenders.

For tracing the further course of Alexander's operations in Swāt we can fortunately avail ourselves of archæological as well as topographical indications. Arrian † tells us that Alexander

"then dispatched Koinos to Bazira, believing that [the inhabitants] would capitulate on learning of the capture of Massaga. He further sent Attalos, Alketas, and Demetrios the cavalry leader, to Ōra, another town, with instructions to invest the town until he himself arrived. A sally made from the latter place against the troops under Alketas was repulsed by the Macedonians without difficulty and the inhabitants driven back within their walls. With Koinos matters did not fare well at Bazira; for its people trusted to the strength of the position, which was very elevated and everywhere carefully fortified, and made no sign of surrender.

"Alexander on learning this set out for Bazira. But having come to know that some of the neighbouring barbarians, prompted to this by Abisares,‡

* See V. Smith, 'Early History of India,' **2**, p. 50.

† Cf. Arrian, V. xxvii. 5; M'Crindle, *loc. cit.*, pp. 69 *sq.*

‡ By Abisares is meant the king of the territory known from Sanskrit texts by the name of *Abhisāra* and located in the lower and middle hills between the Jhelam and Chenāb rivers; in Alexander's time it comprised also Hazāra; see Stein, 'Rājataraṅgiṇī,' transl., **1**, pp. 32 *sq.*, and below, p. 439.

were preparing by stealth to enter Ōra, he first marched to Ōra. Koinos was instructed to fortify a strong position in front of Bazira, to leave in it a garrison sufficient to keep the inhabitants from undisturbed access to their lands, and to lead the rest of his force to Alexander. When the people of Bazira saw Koinos departing with the greatest portion of his troops, they made light of the [remaining] Macedonians as antagonists no longer equal to themselves and descended to the plain. A sharp encounter ensued in which five hundred barbarians were killed and over seventy taken prisoners. The rest fled together into the town, and were more strictly than ever debarred from access to the land by those in the fortified position."

Subsequently, we are told, when the inhabitants of Bazira learned of the fall of Ōra they lost heart and at the dead of night abandoned the town.

I believe the convergent evidence of position, remains, and name enables us to locate Bazira safely at the conspicuous hill which rises with precipitous rocky slopes above the left bank of the Swāt river near the large village of Bīr-kōṭ and on its top bears the ruins of an ancient fortification. *Bīr-kōṭ*—this is the name as I heard it regularly used by the local people, the "Bari-kot" of the map being the form preferred for some reason in the Persian correspondence of scribes and Mullahs—is a considerable place situated at the point where the three large and well-cultivated valleys of Kandag, Najīgrām, and Karākar, descending from the watershed range towards Bunēr, join and debouch on the Swāt river. Where the broad spur flanking the Kandag valley on the west approaches the left bank of the river it curves round to the north-east. After descending to a low and broad saddle near the village of Guratai it rises again with bare rocky slopes and ends abruptly in a rugged isolated hill, washed at its northern foot by the river. This hill, known as *Bīr-kōṭ-ghundai* ("the hill of Bīr-kōṭ"), terminates at its top in a bold rock pinnacle, with a triangulated height of 3093 feet. Its maximum elevation above the point where the united stream passing Bīr-kōṭ village joins the river is close on 600 feet.

The hill is roughly crescent-shaped and falls off on its convex side towards the river with precipitous rocky slopes, very difficult to climb and in places quite impracticable. On the concave side to the south the central portion of the hill is lined with unscalable crags, culminating in the rock pinnacle already mentioned. Towards the south-west the hill runs out in a narrow rocky ridge, utterly bare throughout and in addition for the last 300 feet or so of its height very steep. The south-eastern extremity of the hill which runs down towards Bīr-kōṭ village presents a rocky crest and for the most part is also very steep. But here and there the slope affords room for small terraces, and these are covered throughout with debris from stone walls of roughly built habitations and with abundance of potsherds.

Above the highest and largest of these terraces there rises an imposing stretch of wall (Fig. 1), massively built with rough but carefully set stone slabs, to a height of close on 50 feet. Extending

for a distance of about 80 yards and facing to the south-east, this wall protected the fortified top of the hilltop on that side where the natural difficulties of attack were less than elsewhere. At the same time the ground filled up behind it served to enlarge considerably the level space available on the top. This wall, which is clearly visible from the lands by the village and river, continues at approximately the same height to the north. It forms there a bastion-like projection, and then with a re-entering angle turns round the head of a precipitous rocky ravine which runs down to the river. From there the line of the circumvallation, less massive and less well preserved, is traceable all along the river front. From where a small mound marks the north-western end of fairly level ground on the fortified hilltop the wall turns for short stretches to the south and south-east. Here remains of small towers or bastions (Fig. 2) occupy projecting rocky knolls and protect that face of the top which was exposed to attack from the previously mentioned narrow ridge descending to the saddle above Gurutai.

From the point where the wall turns to the south-east its line could be followed only for a short distance. The hill is crowned here with sheer cliffs, and no fortification was needed to make it unassailable from the plain. Here the rocky pinnacle already referred to rises steeply to a height of about 60 feet above the level plateau formed by the rest of the hilltop. The sides facing this bear remains of ancient masonry wherever there was room for walls. This and the abundant pottery debris strewing the slopes and summit clearly indicate that this steep knoll had been turned into a kind of keep and occupied for a prolonged period.

The level ground of the circumvallated area on the top measures over 200 yards from north-west to south-east, with a maximum width of over 80 yards. Plenty of low ruined walls cover the whole of it, marking badly decayed habitations. A mound rising to a height of about 12 feet above the bastion at the south-eastern end may hide the remains of a completely destroyed Stūpa. Another and somewhat lower debris mound at the opposite north-western extremity of the area might also be taken for a ruined Stūpa, but for the masses of broken pottery which lie thickly on its top and all round. Most of the decorated pieces of pottery which were picked up at this site show types which, in view of subsequent finds at approximately datable ruins of Upper Swāt, can be definitely assigned to the Buddhist period.

What time I could spare for this ancient stronghold from the survey of the numerous and interesting Buddhist ruins in the several valleys above Bīr-kōṭ would not allow of any attempt at excavation. But on the line of wall protecting the north-western end of the hilltop (Fig. 2) we came upon curious relics of the means once employed for its defence. We found there numbers of round water-worn stones, undoubtedly brought from the river-bed, of different sizes such as would be used for slings or as heavier missiles. In one heap which a little experimental digging

revealed as one of the ruined towers, there came to light not less than thirty-eight " rounds " of such antique ammunition.

An assured water-supply was essential for the occupation of the site as a stronghold, and in this respect the hill of Bīr-kōṭ was very favourably situated. A main branch of the Swāt river flows round the rocky northern slopes and washes their base so closely that no practicable track can be found there. The steepness of the eroded slopes shows that the river must have flown past there for ages. It is certain that as long as the hilltop was defended it was very difficult for an enemy to cut off access to the river-bank. There might have been defences on this side also; for when I descended from the hilltop, in places with difficulty, on the slope to the west of the above-mentioned ravine I noticed remains of old walls and everywhere abundance of ancient potsherds. Walled-up terraces and remnants of old foundations clinging to the rocky slopes were found also to the east of the ravine.

There is some reason to suppose that the occupants of the ancient fastness were not content to trust for the safety of their water-supply entirely to the natural defence provided by the precipitous slopes. I had been told of two rock-cut passages leading into the hill from above the river, and on my descent from the top was shown the entrance to one of them at an elevation of about 180 feet above the river. The height of the entrance is only about 4 feet at the outside. But once a low doorway, built with masonry of the peculiar type familiar from Buddhist structures in Gandhāra, is passed the height of the gallery, vaulted with horizontal courses of roughly cut slabs, rises to over 10 feet. The width of the gallery between the masonry lining is about 3 feet. In places this lining had fallen and left the rock walls bare. I could ascend the gallery only for *circ.* 16 yards, where I found it blocked by fallen rock. Recesses for a square bolt on either side of the low doorway showed that it could be closed from the inside.

After descending the precipitous slope to about 100 feet above the river, I was shown the exit of another tunnel farther to the east. It could be entered only with some difficulty, and looked in places more like a succession of natural rock fissures which had been utilized by man. Here, too, ancient masonry of the Gandhāra type was to be seen in places over the distance of some 25 yards which alone was possible of ascent. Large fallen blocks of stone barred progress beyond. Judging from the local reports both passages had often been searched for " treasure." Only thorough clearing which would claim time and adequate preparations, could furnish definite evidence as to their direction and purpose. But that one of them, if not both, were meant to provide safe access to water for those holding the fortified hilltop appears to me distinctly probable.

The great antiquity of the site and its prolonged occupation are abundantly attested by the plentiful finds of coins which are made on the top of the Bīr-kōṭ hill and on its slopes, especially after rain. Most

of the coins are melted down promptly or, in the case of gold and silver pieces, find their way down to dealers at Peshawar or Rawalpindi. But even thus a rapid search made at Bīr-kōṭ village secured me a large miscellaneous collection of copper coins of pre-Muhammadan date. The specimens range from issues of the Indo-Greek and Indo-Parthian kings and of the Indo-Scythian or Kushana rulers down to the mintages which preceded the downfall of the Hindu Shāhi dynasty before Maḥmūd of Ghazna, about the beginning of the eleventh century. Most numerous are pieces issued by Azes, Azilises, and other Indo-Scythian kings who exercised extensive rule on the north-western confines of India during the first century B.C., as well as specimens of the copper coinage of the Kushana Emperors who succeeded them.

But coin finds of these early periods are not confined to the Bīr-kōṭ hill alone. They are very frequent too at the numerous sites, marked by remains of Buddhist sanctuaries and ancient settlements, which I was able to trace in the vicinity of Bīr-kōṭ village and in the side valleys which debouch there. The results of the rapid archæological survey I was able to carry out during the four days of March, while my camp stood at Bīr-kōṭ, conclusively prove that Bīr-kōṭ must have been the centre of a populous and important tract during the centuries which immediately preceded and followed the beginning of the Christian era. The great natural advantages for defence which the isolated rock-girt hill of Bīr-kōṭ offered, are likely to have been appreciated long before the period to which the oldest of the coins there found belong. Only systematic excavation could show how far back the occupation of the stronghold dates. But that it existed already at the time of Alexander's invasion, and that it is the place to which Arrian's account of the siege of Bazira refers, can, I think, be proved by convergent topographical and philological evidence.

To take the topographical indications first, it is clear that the Bīr-kōṭ hill fully answers the description given of the position of Bazira, "which was very elevated and carefully fortified." It is easy to understand why no rapid success could be gained there by the force under Koinos, and why Alexander while himself marching upon Ōra was content, instead of attempting a direct siege of Bazira, to leave a small portion of Koinos' troops behind for the purpose of masking the stronghold. The hill of Bīr-kōṭ was a place very difficult to take by anything less than a protracted and arduous siege. It also was a position from which it was easy for Alexander's opponents to block the main road leading up the Swāt valley and to interfere with whatever operations he might wish to carry out in that direction. Hence the order to Koinos "to fortify a strong position in front of Bazira," and "to leave in it a garrison sufficient to keep the inhabitants from undisturbed access to their lands." Where that fortified camp is likely to have stood it is impossible to state. But from what I saw of the ground it appears to me that the elevated area

now occupied mainly by graveyards just above the point where the streams coming from the Karākar and Kandag valleys meet, about half a mile from the foot of the Bīr-kōṭ hill, would have well served the tactical needs in view.

On the philological side it is easy to prove that the name *Bīr-kōṭ*, "the castle of Bīr," preserves in its first part the direct phonetic derivative of the ancient name which the Greek form *Bazira* was intended to reproduce. The Greek letter ζ, *z*, was regularly used for the rendering of both the palatal media *j* and the palatal semi-vowel *y*, two sounds common in the Indo-Aryan and Dardic languages but not known to the Greek alphabet, and *vice versâ*. This is conclusively shown by the evidence of Greek transcriptions of indigenous names belonging to the very region and period with which we are here concerned. Thus in the Greek legends of coins issued by rulers on the North-West Frontier within three centuries of Alexander's invasion we find the name of an Indo-Parthian Satrap who is called *Jihuṇia* in the Kharoshṭhī legend of his coins rendered by Zeionises in the Greek legend of the obverse, while the name of the Greek king Zoilos is reproduced in Kharoshṭhī script on the reverse of his coin as *Ϝhoïla*.* The two Indo-Scythian kings who are known from their Greek legends as Azes and Azilises and whose coins are found with exceeding frequency at sites of Swāt, are called *Aya* and *Ayiliṣa* in their Kharoshṭhī legends. On the Greek side of the coinage issued by the founder of the Kushan dynasty his name appears as Kozulo Kadphises while the Kharoshṭhī legend of the reverse renders it by Kujula Kasa.† Similarly we find the early Turkish princely title of *jabgu* on the coins of the Kushān Kadaphes reproduced by *Zaoou* in the Greek writing of the obverse, and by *Yaüa* in the Kharoshṭhī of the reverse.‡

From the restored form **Bajira* : **Bayira* it is not difficult to trace the gradual phonetic change into *Bīr* or *Bir*. In the development of all Indo-Aryan languages, as illustrated by the transition from Sanskrit into Prakrit and from this into the modern Indo-Aryan vernaculars, the elision of intervocalic mediæ *j* and *y* is a well-known rule, and this holds good also of the related Dardic languages.§ The subsequent reduction of the resultant diphthong *ai* in **Baira* into *ī* or *i* is a phonetic change for which analogies are equally plentiful in the two language groups.‖ In the same way the disappearance of the final short vowel under the

* See *e.g.* Whitehead, 'Catalogue of Coins in the Panjab Museum,' **1**, pp. 65, 157.

† Cf. *ibid.*, **1**, pp. 104 *sqq.*, 133 *sqq.*, 179. On certain coins of Kozulo Kadphises and of Kadaphes, his supposed successor, the first part of the name is rendered by the Kharoshṭhī legend as *Kayala* or *Kuyula*; cf. *ibid.*, pp. 180 *sqq.*

‡ See Marquart, 'Erānšahr,' pp. 208 *sq.*

§ Cf. Grierson, "Paiśācī, Piśācas, and Modern Piśāca," in *Z.D.M.G.*, 1912, p. 79; 'The Piśāca languages of North-Western India,' pp. 109 *sq.*

‖ See Grierson, "The Phonology of the Modern Indo-Aryan Vernaculars," in *Z.D.M.G.*, 1895, pp. 407 *sq.*, 419.

influence of the stress accent on the penultimate conforms to a phonetic law uniformly observed in all modern Indo-Aryan and Dardic vernaculars.* Thus we can account without any difficulty for the successive change of **Bajira* (*Bayira*)>**Baira*>*Bīr*. The addition of the designation *kōṭ*, "castle, fort" (Sanskrit *koṭṭa*), to the name is readily understood, the term *kōṭ* being generally applied to any fortified place throughout the North-West of India, whatever the language spoken.†

In view of what has just been stated as to the probable pronunciation of the name recorded by Arrian as Bazira, it is of special interest to note that we find the same place mentioned by Curtius under the name of *Beira*.‡ His notice, very brief, follows upon the account of the operations which Arrian more clearly relates as having taken place in the country of the Aspasiol and Gouraioi, *i.e.* in Bājaur. We are told that Alexander, "having crossed the river Khoaspes, left Koinos to besiege an opulent city—the inhabitants called it Beira—while he himself went on to Mazaga." I have elsewhere indicated the reasons for believing with Marquart that by the Khoaspes the Panjkōra is meant, which Arrian more correctly calls Guraios.§ Though Curtius, manifestly by error, makes the siege of Beira simultaneous with, instead of subsequent to, that of Mazaga (Massaga), yet there can be no doubt, in view of the reference to Koinos, that the Beira he mentions is identical with Arrian's Bazira. His form of the name is obviously but another attempt to reproduce the indigenous designation of *Bajira or *Bayira.

Curtius tells us nothing more of the stronghold now safely located at Bīr-kōṭ. From Arrian, too, we only learn that the people of Bazira, when they heard of the fall of Ōra, "lost heart and at the dead of night abandoned the town; [they fled to the rock]. Thus the other barbarians, too, did; leaving their towns, they all fled to the rock in that country called Aornos." Before we follow Arrian's narrative further in order to look for the probable site of Ōra and then to trace the true position of that much-discussed fastness of Aornos, I may note here two observations bearing on this flight of the people of Bazira. One is that in the text of Arrian the words of which the rendering has been put above into brackets have been treated as an interpolation, rightly as it seems, by some editors. Hence the text does not necessarily imply that they too fled to the "rock" of Aornos. The other is that topographical considerations seem to me distinctly averse from this interpretation.

We shall see that the position of Aornos must certainly be looked for close to the Indus. Now the shortest distance from Bīr-kōṭ to any point on the right bank of the Indus where a hill fastness corresponding in

* Cf. Grierson, *loc. cit.*, p. 400.

† The term *kōṭ* is quite common in local names of Hindukush valleys, like Darēl and Tangīr, where Dardic languages are spoken, and is used also separately in Pashtu.

‡ See 'Historia Alexandri,' VIII. x.

§ Cf. Stein, 'Serindia,' **1**, p. 2, note 2; Marquart, 'Untersuchungen zur Geschichte von Erān,' **2**, pp. 243 *sq.*

general features to Aornos could possibly be situated, is over 32 miles as the crow flies, and to the spur of Pīr-sar where I believe Aornos to be located is fully 40 miles. The straight line to which these measurements apply would lead right across a succession of steep hill ranges, and if a route following easier ground along valleys and across passes were chosen, the distance would certainly be still greater. One such route, as the map shows, would have led up the main Swāt valley and thence across one of the passes eastwards to the Indus. But this route was in all probability barred by the Macedonian main force operating, as we shall see, higher up on the river.

A nearer and far safer line of retreat would have lain to the south-east up the Karākar valley, which descends straight to Bīr-kōṭ from the main Swāt–Bunēr watershed; by it the fugitives could have reached within little more than a single night's march a mountain refuge as secure as any that might be sought by them far away on the Indus. I mean Mount Ilam, that great rocky peak, rising to 9250 feet above sea-level, which dominates the watershed range between Upper Swāt and Bunēr, and with its rugged pyramid-shaped summit forms a very conspicuous landmark for both territories. The top of Mount Ilam is girt on all sides with crags and very precipitous slopes which would render an attack upon those holding it most difficult if not practically impossible. The top is formed by two distinct rocky eminences enclosing a hollow space which holds a spring and affords room for a small camp. Sacred legends have clung to this mountain since Buddhist times, as the record of the famous Chinese pilgrim Hsüan-tsang shows,* and its top is still the object of an annual pilgrimage by the Hindus of Swāt and neighbouring parts. A track used by modern pilgrims leads up to Mount Ilam from the side of Bīr-kōṭ through the picturesque Nullah of Amlūk-dara, a branch of the Karākar valley holding fine Buddhist ruins. The distance from Bīr-kōṭ to the top may be estimated at about 11 miles. In view of these local observations the suggestion appears to me justified that the place of safety sought by the fugitives from Bazira was much more likely to have been Mount Ilam than the distant Aornos by the Indus.

The definite identification of Bazira (or Beira) with the ancient fortress above Bīr-kōṭ may help us to locate also the town of Ōra, Ὦρα, which Arrian's above-quoted account of Alexander's operations after the fall of Massaga brings into obvious relation with its siege. We have seen that Alexander, after having set out for Bazira, subsequently was induced to proceed straight to Ōra, for the preliminary investment of which he had previously dispatched certain detachments. From the fact that he ordered Koinos, who stood before Bazira, to join him for the attack upon Ōra with the main portion of his force, and at the same time took care

* For the identification of Hsüan-tsang's *Hi-lo* mountain with Mount Ilam, first proposed by M. Foucher, 'Géographie ancienne du Gandhāra,' p. 48, and confirmed by what I saw on my visit in May 1926, cf. 'Serindia,' I, p. 16.

to have Bazira masked by the remainder holding a post of observation, we may reasonably draw two conclusions: One is that Ōra is likely to have lain in the same direction as Bazira but beyond it, and the other that Ōra was a place of importance which Alexander felt prompted to secure quickly in view of the reported move to reinforce its defenders.*

Taking into account the general geographical features, we are thus led to look for Ōra higher up in the main Swāt valley and at some point which the presence of ancient remains would definitely indicate as having been occupied by a fortified town of importance in early times. Now the Upper Swāt valley above Bīr-kōṭ at present shows a number of large villages which might be called towns, such as Mingaora, Manglawar, and Chārbāgh, all on the left bank of the river. But at none of these did I succeed in tracing definite evidence of ancient fortification. Nor did I learn of such remains at any of the large villages to be found near the right bank. It is different at Uḍegrām, a considerable village and now seat of a "Tahsīl," situated about 10 miles by road above Bīr-kōṭ, where the fertile and well-irrigated riverine plain attains its widest in Upper Swāt.

Immediately to the south-east of the village there opens the mouth of a small side valley descending from a steep rocky hill range behind which there lies to the east the large valley of Saidu. The crest of this rugged range rising close on 2000 feet above Uḍegrām, and the extremely precipitous slopes which run down from it westwards, bear a very remarkable mountain fastness, undoubtedly of ancient date, known to the local Pathāns as "King Gira's castle." A full description of the site must be reserved for another place. But the few following details will help to convey some idea of the peculiar hill formation which here had offered itself as a natural stronghold.

Where the serrated crest of the range, only some 20 yards across at the widest and in places a mere knife-edge, overlooks the valley of Saidu, it falls off with sheer vertical rock walls for hundreds of feet. Yet even on this side where a successful attack would scarcely have been practicable for the boldest climbers, remains of massive walls cling to the bare rocky crest for a distance of over 500 yards. From the ends of this fortified top ridge there descend two very narrow and precipitous spurs of bare rock crowned with the flanking walls of the stronghold (Fig. 3). These walls, about 7 feet thick on the average, are built of carefully packed courses of rough stones which have been set in mud plaster now hardened. Notwithstanding their apparently insecure position on steep slopes, these walls still stand in places to a height of 9–10 feet. About 1000 feet below the crest the gradual convergence of the rib-like rock spurs makes the two flanking lines of wall approach each other within some 200 yards. Here a line of very massive walls, bearing terraces and in places

* See above, pp. 426–7.

strengthened by small bastions, curves round from the west and joins them up.

Within the area thus protected and only a little above the point where this cross-line of wall runs close to the northern flanking wall, there issues a fine perennial spring from among big boulders filling the bottom of an otherwise dry torrent bed. It was the presence of this spring, the only source of water available within the fortified area, which rendered it capable of use as a place of safety. The importance attached to the spring is shown by the massive construction of the walls, here doubled, which descend into the gorge to defend it. Wherever higher up on the rocky slopes terraces or little ledges afforded room ruined walls of dwellings mark ancient occupation. Their far-advanced decay as compared with the remains of Buddhist monastic quarters, etc., surveyed at other sites, distinctly points to great antiquity. Plenty of low crumbling walls from ancient structures are to be met with lower down, too, amidst the thick growth of scrub and thorny trees which covers the widening gorge below the bottom portion of the defences. Such remains are equally frequent also at the foot of the southern spur. There a succession of walled terraces, all once, no doubt, occupied by houses, orchards, or fields, affords the easiest approach to the fortified area. This explains why we found the fairly level ridge where the flanking wall on that southern spur ends, guarded by a particularly massive bastion still rising in places to a height of over 20 feet.

Pottery debris of distinctly ancient type could be picked up in plenty over most of the ground here briefly described. Yet in view of the extreme steepness of the slopes over which the remains of ruined dwellings within the walled area are scattered, and the consequent inconveniences of approach and communication between them, it seems to me hard to believe that these quarters were regularly occupied except at times of danger. On the other hand, the construction of massive defences on such difficult slopes and up to 1000 feet above the nearest water must have implied such exceptionally great efforts that it is not likely to have been undertaken except for the purpose of assuring a safe retreat for the inhabitants of an important locality. For such a place the open mouth of the valley towards Uḍegrām village, now covered with extensive Muhammadan burial-grounds and sacred groves belonging to the Ziārat of Pīr Khushhāl Bāba, would have afforded ample room. Finds brought to me of small fragments of Græco-Buddhist sculpture, an inscribed seal, and coins belonging to Indo-Greek and Indo-Scythian issues distinctly indicated early occupation of this ground. But owing to its sacred character no systematic search was there possible. Muhammadan local tradition ascribes the conquest of "King Gira's fortress" to Maḥmūd of Ghazna, whose forces after a long siege took it from the last infidel king of Swāt under the leadership of the saint now buried at the Ziārat below.

It has appeared to me desirable to record these observations about the remarkable hill stronghold above Uḍegrām in some detail; for the indications already discussed as to the direction of Alexander's operations beyond Bazira, in conjunction with what I shall presently show about the name of the place, suggest the question whether we ought not to look there for the probable location of Ora. Unfortunately, Arrian's further brief mention of Ōra supplies no topographical or other local hint. It is confined to the bare statement that "Alexander did not find the siege of Ōra difficult, for he took the town on the first assault against its walls and secured the elephants left behind there." Nor does Curtius' account help us. He mentions indeed a place Nora to which Alexander dispatched a force under Polysperchon after the capture of Mazaga, and this has been generally assumed to be the same as Arrian's Ōra. But all we are told about it is that Polysperchon "defeated the undisciplined multitude which he encountered and pursuing them within their fortifications compelled them to surrender the place." *

As regards the name *Uḍegrām*, it should be explained in the first place that it is certainly a compound of which the second part is the word *grām*, "village" (Sanskrit *grāma*), well known to Dardic languages and very common in local names of Swāt, as a reference to the map shows. The first part *Uḍe-* (also heard as Uḍi-) is pronounced with that distinctly cerebral media *ḍ* which to European ears always sounds like a cerebral *r*, and often undergoes that change to *r* also in Modern Indo-Aryan as well as in Dardic languages.† The temptation is great to recognize in Arrian's Ὦρα the Greek rendering of an earlier form of this name *Uḍe-*, and to derive the latter itself from that ancient name of Swāt which in its varying Sanskrit forms of *Uḍḍiyāna*, *Oḍḍiyāna*, has been recovered by M. Sylvain Lévi's critical scholarship from a number of Buddhist texts.‡ The simplification of the double consonant *ḍḍ*, the complementary lengthening of the preceding vowel *ū* (*ō*), which would explain the long initial vowel in Ὦρα, and the subsequent shortening of this vowel in modern *Uḍe-* (when becoming the antepenultimate in the compound Uḍegrām), all these phonetic changes assumed in the history of the name can be fully accounted for by well-known rules affecting the transition of Sanskrit words into Prakrit and thence into modern Indo-

* Cf. Curtius, VIII. xi.

† Cf. Grierson, *loc. cit.*, *Z.D.M.G.*, 1896, p. 5; 'Piśāca Languages,' p. 104. For an example of *ḍ* being rendered by Greek *r*, cf. Ptolemy's name *Larikē* for Gujarāt, reproducing a Prakrit derivative **Lāḍikā* of the Sanskrit name *Lāṭa*; also Weber, "Greek pronunciation of Hindu words," *Indian Antiquary*, 2, p. 150.

‡ See S. Lévi, "Le catalogue géographique des Yakṣa dans la Mahāmāyūrī," *Journal Asiatique*, 1915, janv.-févr., pp. 105 *sqq*. There, too, it has been convincingly shown that the form *Uḍyāna* ("the Garden"), commonly accepted by European scholars as the Sanskrit name of Swāt, is but an *idolum libri*, based upon a "learned popular etymology" which a gloss on the Chinese notice of Swāt in Hsüan-tsang's *Hsi-yü-chi* first records.

South-eastern portion of fortifications on Bīr-Kōṭ hill

Ruined towers at north-west end of Bīr-Kōṭ hill

Wall on northern spur flanking ancient stronghold above Udegrām

Aryan forms.* Nevertheless, it will be well to bear in mind that the nexus of names here indicated must remain conjectural until epigraphical or other evidence helps to establish it.

Arrian, after recording the fall of Ōra and the abandonment of other towns by their "barbarian" inhabitants, has nothing to tell us of further operations in the country of the Assakēnoi. He gives a brief description of that mighty mass of rock called Aornos to which they all had fled, and relates how the fame of its impregnability fired Alexander with an ardent desire to capture it.† This account of Aornos may be left for discussion further on. We are next told that he turned Ōra and Massaga into strong places for guarding the country and fortified Bazira. Then the narrative takes us suddenly south to that division of his army which under Hephaistion and Perdikkas had been sent down the Kābul river to secure the Peshawar valley. Under Alexander's orders they had fortified there a town called Orobatis, for which no satisfactory location has as yet been found; having garrisoned it, they had proceeded to the Indus to bridge it.

That Alexander himself had with the capture of Ōra concluded his campaign in the Swāt valley and moved across the hill range into the Peshawar valley is clear from what follows. He is said to have marched to the Indus and to have received the submission of the city of Peukelaōtis, where he placed a Macedonian garrison. This city has long ago been identified with *Pushkalāvatī*, the ancient capital of Gandhāra, close to the present Chārsadda on the Swāt river and north-east of Peshawar. It is wrongly described by Arrian as lying not far from the Indus. The error must warn us as to possible geographical mistakes even in the most reliable of the narratives dealing with Alexander's Indian campaign. We are next told that Alexander "reduced other towns, some small ones situated on the Indus," while accompanied by two chiefs of this territory; their names, Kophaios and Assagetes, are unmistakably Indian.

Before I proceed to analyze the data we possess concerning the famous "rock of Aornos," to the siege and conquest of which Arrian's account now immediately turns, it will be convenient briefly to indicate certain considerations of a quasi-geographical order which, I believe, deserve specially to be kept in view when looking for the right identification of that much-discussed site. We have seen that Alexander's operations along the Swāt river must have covered Lower Swāt and that most fertile and populous portion of Upper Swāt which extends to the great bend of the valley near Mingaora above Uḍegrām. We have also learned that after the fall of Ōra, which must certainly be located above Bīr-kōṭ and

* Cf. Grierson, *loc. cit.*, *Z.D.M.G.*, 1895, p. 414; 1896, pp. 21 *sqq*. Closely corresponding rules can be shown to have affected also the phonetic development of Dardic languages, especially of that Sanskritized Dardic tongue which, from the evidence of the present Tōrwālī and Maiyā in the Swāt and Indus Kohistān, must be assumed to have been spoken in Swāt before the Pathān conquest.

† See Arrian, IV. xxviii. 2.

Ruined towers at north-west end of Bīr-Kōṭ hill

Wall on northern spur flanking ancient stronghold above Uḍegrām

probably below that bend, all the inhabitants abandoned their towns and fled for safety to "the rock of Aornos."

Now if we look at the map and keep in mind the situation created for the Assakēnoi by the Macedonian posts established at Massaga and Ora, it will be clear that the bulk of the fugitive population evacuating the towns farther up the valley could have sought safety neither to the west nor to the south. In the former direction the way was obviously barred by the invaders. To the south as far as it could be reached by routes not commanded by the Macedonian posts guarding the main valley, there lay Bunēr, a country singularly open for the most part and accessible by numerous passes from the side of the Peshawar valley. The plains of the latter had already been reached by the portion of Alexander's army sent down the Kābul river; thus Bunēr, too, lay open to invasion.

Safe lines for general retreat were obviously restricted to the north and east. In the former direction the main Swāt valley continues remarkably easy and open for a distance of close on 30 miles above Mingaora, and the same remark applies to the side valleys opening from it, at least in their lower parts. No safe refuge from invasion, so swift and determined as that of Alexander, could be hoped for there. Higher up where the Swāt river breaks through the narrow gorges of Tōrwāl, invasion would, no doubt, be kept off by the natural difficulties of the ground. But there, just as at the high alpine heads of the valleys which descend to the Swāt river from the snow-covered watersheds towards the Panjkōra and Indus, local resources would have been far too limited for the maintenance of a great host of fugitives. Nor should the great climatic hardships be ignored which those fleeing from the towns of the valley plain would have had to face at the time in those alpine parts of Swāt. We know that the Macedonian invasion must have reached Swāt in the late autumn of B.C. 327, and the rigours of the approaching winter to be faced high up in the mountains would have sufficed to deter any large numbers from seeking safety northward.

Conditions were distinctly more favourable to the east. There a number of large and for the most part very fertile valleys comprising the tracts of Ghōrband, Kāna, Chakēsar, Pūran, and Mukhozai stretch down to the Indus from the Swāt watershed. They can be reached by several easy passes, none much over 6000 feet in height. All are throughout the year practicable for laden mules and ponies, from the open side valleys which leave the Swāt river at the large villages of Manglawar, Chārbāgh, and Khwāja-Rhela, respectively. A single day's march from the riverine plain of Swāt suffices to bring the traveller over any of these passes to the head of the Ghōrband valley, whence access is easy to the rest of those valleys. In addition there are routes from Mingaora, more direct if not quite so easy, connecting that important place in Central Swāt with Pūran and Kābalgrām on the Indus.

The advantages which this side would offer for retreat from invaded

Swāt are clear enough. By crossing the watershed range towards the Indus the fugitives would place a natural barrier between themselves and the enemy. In the tracts there reached they could count upon finding resources sufficient for their maintenance until the danger had passed.* The great distance intervening between those tracts and the Peshawar valley might offer protection from the Macedonian forces in the plain. Finally, having secure access to the Indus, they could easily draw help from across the river when further attack threatened, or else continue their retreat to that side if fresh resistance failed.

With regard to the last-named advantage the evidence available from historical facts both ancient and modern may conveniently be at once pointed out here. We have seen already above that what prompted Alexander to hasten in person to the siege of Ora was the news of assistance being sent to its defenders by Abisares.† It is true that the Abhisāra territory whose king is here meant comprised in later times mainly the lower and middle hill tracts to the east of the Vitastā or Hydaspes, the present Jhelam.‡ But there is good reason to believe that at the time of Alexander's invasion its ruler's power extended also over the hill portion of Uras'ā, the present District of Hazāra, east of the Indus. This is proved by what Arrian tells us of the Indians who after the capture of Aornos had fled from neighbouring parts across the Indus to Abisares, and also by what he subsequently relates of an embassy from Abisares which Arsakes, ruler of an adjacent territory, attended as a feudatory.§ It has been recognized long ago that by Arsakes the chief of Uraśā is intended, the territory which in Ptolemy's 'Geography' appears under the name of Ἄρσα or Οὔαρσα.‖

The close relation between Swāt and Hazāra is fully explained by the map. This shows us that the above-mentioned tracts of Chakēsar and Ghōrband are faced immediately to the east of the Indus by the comparatively large and open valleys of Nandihār and Allāhī. These are now occupied by Pathān tribes, all here, as also farther down by the Black Mountain, closely linked with those established on the other side of the river. From these valleys easy routes lead to Agrōr and the

* The extent of these resources even at the present time is illustrated by the following data ascertained on my passage through Chakēsar and Pūran. Both tracts have suffered severely from protracted local feuds as well as by the heavy fighting which preceded their conquest by the Miāngul in 1923. Yet the revenue in kind paid now to the ruler of Swāt at the lightly assessed rate of one-tenth of the produce was reckoned at 6000 maunds of grain for Chakēsar and at about 4000 maunds for Pūran. Yet in the latter area I noticed that a very great portion of the available land had gone out of cultivation. In Chakēsar, too, abandoned cultivation terraces could be seen in many places. Half-deserted villages were conspicuous in Kāna and in what I saw of Ghōrband.

† See Arrian, IV. xxvii. 7; above, pp. 426–7.

‡ Cf. Stein, 'Rājataranginī' transl., notes on i. 180; v. 217.

§ Cf. Arrian, IV. xxx.; V. xxix.

‖ For the identification of Arsa and Arsakes, cf. my note on 'Rājataranginī,' v. 217.

fertile central plain of Hazāra known as Pakhli, about Mansehra and Baffa. This geographical nexus is well illustrated by the fact that the population of this part of Hazāra is largely composed of a tribe known as Swātīs, descended from the pre-Muhammadan inhabitants of the Swāt valley whom historical records and living tradition alike prove to have been driven out of their original seats by the Pathān invasion of the fifteenth century. The same close relation is reflected also, to come down to very recent times, by the fact that during the several Black Mountain expeditions since the annexation of the Panjāb, the various Pathān tribes settled on both the Swāt and the Hazāra sides of the river always took their common share in the fighting.

(*To be continued.*)

PROGRESS IN THE STUDY OF THE HYDROLOGY OF THE NILE IN THE LAST TWENTY YEARS

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Read at the Meeting of the Society, 13 June 1927.

PREVIOUS papers to the Society on the subject of the Nile were read in 1908 by Sir William Garstin and in 1909 by Sir Henry Lyons, and I am honoured by being asked to follow them.

Many workers have contributed to the results to be described, of whom one may mention Sir Wm. Garstin, Sir Henry Lyons, Sir Murdoch MacDonald, Sir Ernest Dowson, Messrs. C. E. Dupuis, P. M. Tottenham, J. I. Craig, E. P. Shackerley, D. A. F. Watt, W. D. Roberts, E. W. Buckley, O. L. Prowde, A. B. Buckley, F. Newhouse, G. W. Grabham, Dr. P. Phillips, E. S. Waller, and R. P. Black. It will be realized that there are many other officials of the Irrigation, Survey, and Physical Departments without whose energy and devotion to duty the work on the Nile could not have been accomplished, and that the men who have sat in a hot sun recording the revolutions of current meters or pushed lines of levels through bush and swamp are essential agents in the study of the Nile. It is pleasing to record that Egyptian Ministers have always appreciated the value of the information collected, and one may perhaps mention particularly Sir Ismail Sirry Pasha, who was Minister of Public Works during a large part of the period under review. The amount spent by Egypt at the present time in collecting information about the Nile Basin is of the order of £100,000 a year.

The main motive for hydrological studies of the Nile has been the wish to increase the water-supply of Egypt and to distribute it more efficiently. The great landmark in recent history is the re-opening of the Sudan in 1898. Previous to this, knowledge was fragmentary and

ideas as to the part played by the various tributaries of the Nile were erroneous. Thus it was thought that in flood-time the Blue Nile, White Nile, and Atbara contributed approximately equal amounts to the main stream, and it was only in 1902 and 1903, when Sir Henry Lyons sent members of his staff with current meters to measure the discharge of these rivers, that the question of their relative importance was settled.

In 1902 the Aswan Dam was completed. This rendered necessary a detailed study of the *régime* of the Nile in order to control the filling and emptying of the reservoir. At the same time Sir Wm. Garstin realized the necessity for more storage, and formed the Sudan Branch of the Egyptian Irrigation Service to collect data for the different projects for improving irrigation in Egypt and the Sudan.

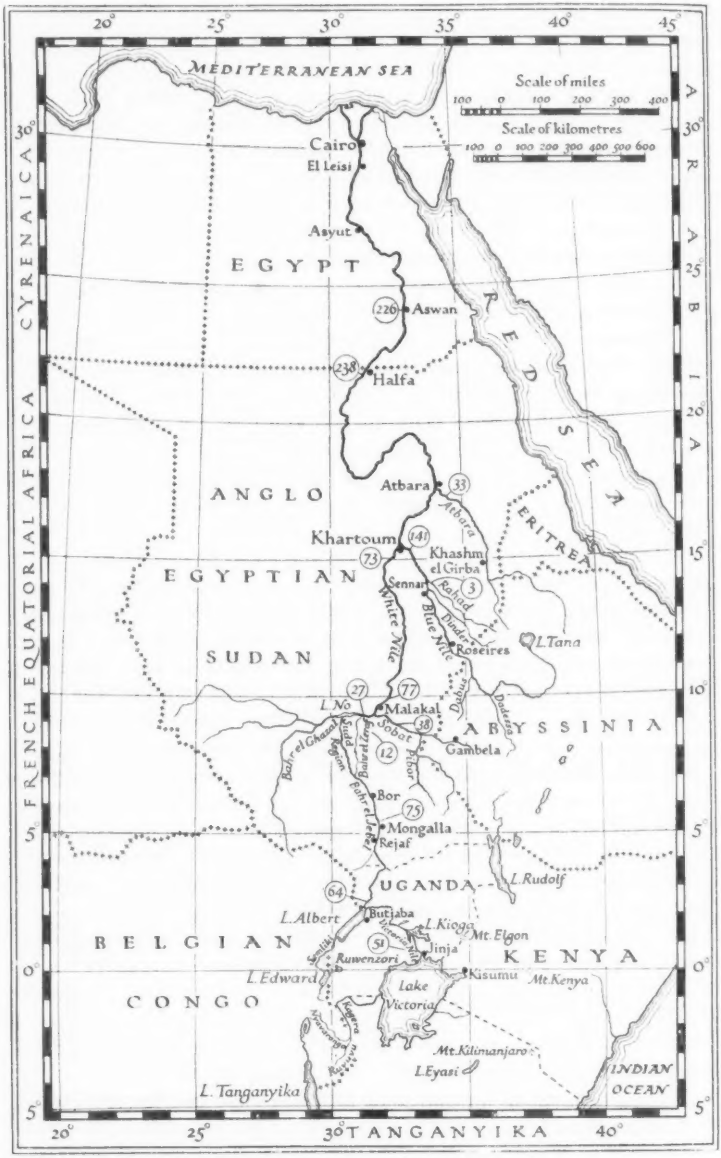
In 1906 Sir Henry Lyons published his 'Physiography of the River Nile,' which contained practically everything of importance which was known at that time about the physics of the Nile Basin. I take this book as the starting-point of my paper, as it was the starting-point of much of the scientific work which has been done since. By this time the main features of the Nile *régime* were understood in a general way, but the exact numerical results required for the expansion of irrigation were lacking.

Hydrology depends primarily upon the measurement of water, and in the past twenty years we have progressed in two directions. We have developed and tested methods of measurement and we have gradually extended the application of these until from the south of the Sudan northward the discharges of the Nile and its tributaries are measured at all important points several times a week. Considering the Nile south of Aswan, in 1906 164 discharges were measured and there were 34 gauges read daily, while in 1926 2607 discharges were measured and 68 gauges were read daily. Thus the last twenty years has not been marked by any startling discoveries, but by the collection of accurate numerical information. It must be remembered that a number of years of regular observations is required before the *régime* of a stream is known. Even now we know very little about the Nile in a year of high flood, because there has not been a really high flood in recent times.

I shall deal first of all with the development of methods of measurement, and then with the results of their application.

Development of Methods of Measurement.

On the Nile it is necessary to know with fair accuracy the volume of water passing various points of its course throughout the year. The ordinary methods of measurement are laborious and do not give a continuous record, and so means are required for interpolating between the individual measurements. The interpolation is done by using the level of the water surface, which is read daily at important points by means of gauges.



1. *Sketch-map of the Nile*

The figures enclosed in circles are average discharges in millions of cubic metres a day

Previous to 1902 the only method of finding the discharge was by measuring the cross-section of the river and determining the surface velocity by means of floats. In 1902 current meters were introduced for measuring velocities, and the float method has become obsolete. If measurements of the discharge are made at frequent intervals a curve showing the relation of gauges and discharges can be drawn, and from this by the use of the daily gauge readings the discharge over a period can be found. In early times it was thought that such a curve was a permanent property of the river at the gauge site. Later experience has shown, however, that owing to changes in the river-bed there are very few sites on the Nile where this assumption gives results accurate enough for modern requirements. It is therefore necessary to keep up regular measurements at all important points.

A method of water measurement of an absolute nature was initiated at the Aswan Dam by Sir Murdoch MacDonald and developed by Mr. Watt and others.* In this method the discharge of one of the sluices of the dam is measured directly by means of a large masonry tank under all conditions of flow, ranging from discharges of 1 to 96 cubic metres a second.

It has been shown that neighbouring sluices do not interfere appreciably with each other, and so the discharge of a number of sluices is got by multiplication of the discharge of one. There are refinements and small corrections to be applied, but the above is the general method whereby the discharge of the river is measured ultimately with a tank. As far as I know, there is no other place in the world where direct measurements of water are made on such a large scale, and they are of far-reaching importance.

This method is only applicable for about half the year during the time when the Aswan Reservoir is storing water, but an extension of it by Watt and myself has led to the discharge in flood-time being measured with almost equal precision.†

By comparing these sluice measurements with those made with Price-pattern current meters, these latter have been shown to give accurate results over a wide range of conditions, though at the top of the flood they appear to give results a few per cent. in excess.

A comparison has also been made between the discharge through an Aswan sluice and that through different scale models, and a simple law has been found to connect the discharge of the model with that of the full-scale sluice.‡ The principle that the discharge of a full-scale sluice can be predicted from that of a scale model is of wide application, and has already been applied to predict the discharge of the sluices of the new Sennar Dam on the Blue Nile. It forms the basis of the present

* MacDonald and Hurst, *Min. of Proc. Inst. C.E.*, Paper 4350 (1920–21).

† Hurst and Watt, *Min. Proc. Inst. C.E.*, Paper 4475 (1923–24).

‡ *Ibid.*, Paper 4450 (1923–24).

measurement of the discharge through the sluices and the measurements of the contents of the reservoir.

It has also been extensively used by Mr. A. D. Butcher, who has done a lot to establish good methods of measurement for the distribution of water in the irrigation canals in Egypt and the Sudan.

Further work on the improvement of methods of measurement will be found in papers by Mr. B. H. Wade and Dr. P. Phillips.*

Application of methods.

Up to the end of 1906 the total number of measurements of discharges with current meters which had been made on the Nile south of Aswan was only 519. Except in a few cases these measurements were made at irregular intervals at sites scattered all over the basin, and may be taken as a reconnaissance to get a general idea of the *régime* of the Nile and the problems to be studied. From 1906 onwards this reconnaissance was being extended and followed up by regular observations at fixed sites.

In the Sudan, hydrological reconnaissance is practically complete except for the streams which flow into the Bahr el Ghazal swamps and for the tributaries of the Sobat. The Bahr el Ghazal streams are not at present important, as most of their contribution is evaporated in the swamps and fails to reach the main stream. Knowledge of the Sobat will become of importance if a dam is built on the White Nile. Outside the Sudan the *régime* of Lakes Victoria and Albert is known in a general way owing to the expeditions of Garstin, Tottenham, and myself, and the information collected about rainfall and lake-levels, but it is time that regular discharge measurements were started.

Very little is known about the *régime* of Lake Edward or of the Kagera, the principal tributary of Lake Victoria. In Abyssinia the *régime* of Lake Tana has been made clear by missions which were there from 1920–1924.† Practically nothing is known of the Blue Nile from Lake Tana to the Sudan Boundary, between which points it receives the bulk of its supply. The thorough study of this portion of the river will be a very formidable undertaking.

The following account of the *régime* of the Nile is based upon the studies mentioned. In Egypt there are two periods of special importance from the point of view of irrigation. The months of August and September, when the flood is at its maximum, are important because a portion of Upper Egypt is still irrigated by the old system by which the land is flooded once a year and gets no other water. A flood of a certain height is required to do this properly, but if the flood is very high there is the danger that banks may burst, and then damage to life and property may occur.

* Physical Department Papers Nos. 4, 6, 7, 13, 14, and 18. Cairo: Government Press.

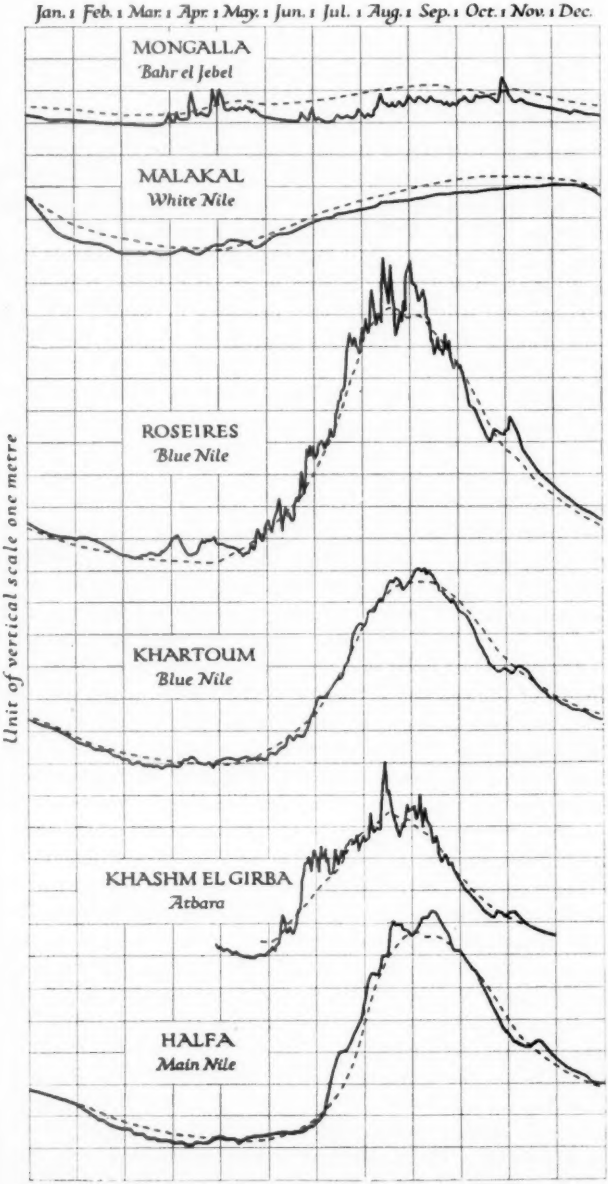
† Grabham and Black, Report of the Mission of Lake Tana, 1920–21. Cairo: Government Press.

1. *Tank measurements of discharge at Aswan sluice*

2. *The Nile above Second Cataract: typical scanty vegetation*

3. *The Blue Nile between Sennar and Roseires at low stream*

4. *Blue Nile north of Roseires, and "meya" flooded at high stream*



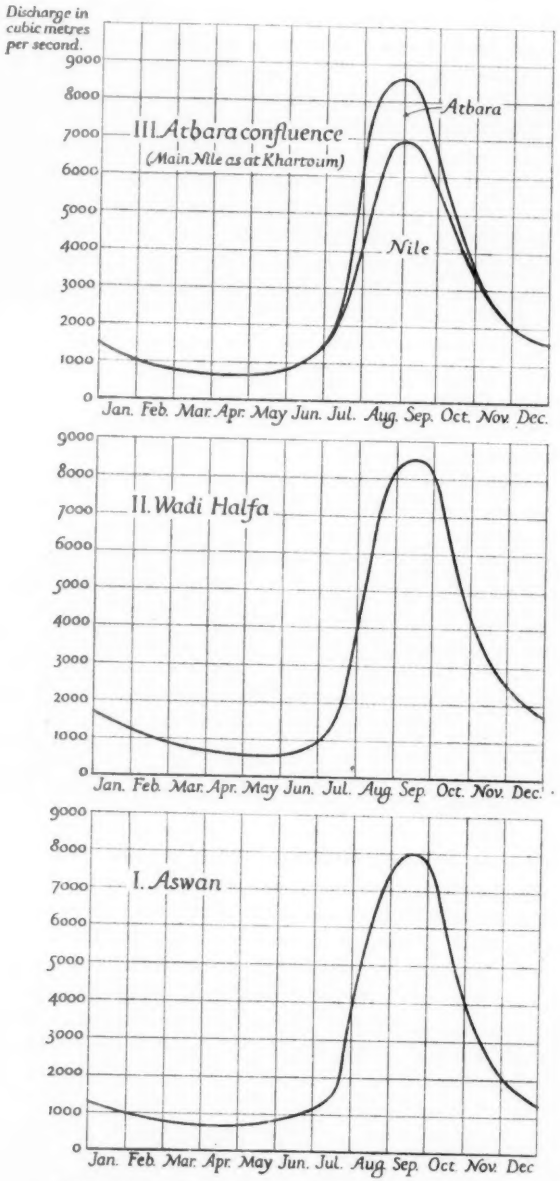
2. *The Nile gaugings in* 1924 (*solid line*) *compared with the means for* 1906-25 (*broken line*)

Most of Egypt is now irrigated on the perennial system whereby it receives water from canals all the year round. During the low season, from March to July, the Nile in Egypt is supplemented by the water which was taken from the river in December and January and stored in the Aswan Reservoir. Throughout this period no water is allowed to escape to sea, and the greatest care is required in its distribution, which is based upon regular forecasts of the supply. These will be discussed later. Thus during flood the height of the Nile is important, while during the low stage it is the quantity of water which matters.

From Khartoum northwards the Nile flows through desert country, except for the narrow strip of vegetation along its banks. From Aswan to Khartoum this strip is usually very narrow. It receives its last tributary, the Atbara, about 1700 miles from its mouth, and from here the Nile decreases in volume towards the sea (Plate No. 2).

The *régime* of the Main Nile is complicated when examined in detail. For example, the total discharge in a year of very high flood may be more than three times the discharge in the lowest known year. The water-supply comes from three main tributaries, the Blue Nile and Atbara, coming from Abyssinia, and the White Nile, which draws part of its supplies from Abyssinia and part from the Lake Plateau of Central Africa. The characters of these rivers are shown in Fig. 2, which gives their levels in 1924 and also their mean levels for a number of years. The Blue Nile and Atbara are streams of a torrential nature with rapid fluctuations during flood time, but during the low stage the Atbara is reduced to a series of pools and the Blue Nile discharge becomes about one-fiftieth of what it was at the top of the flood. It is the Blue Nile, however, which determines the shape of the Main Nile curve. The head streams of the White Nile are subject to fluctuations, but the White Nile itself is a much more regular stream, its discharge at its lowest being on the average rather less than half its flood discharge. The relations of the principal tributaries of the Nile are shown by the curves of average discharge given in Fig. 3, but it must be remembered that individual years depart considerably from the average, and that a good year for the Abyssinian tributaries may be a poor one for those coming from the Lake Plateau. These curves show that on the average two-thirds of the total discharge of the Nile passes in August, September, and October, and again two-thirds of this portion comes from the Blue Nile, while the remainder is divided approximately equally between the White Nile and Atbara. On the other hand, in April and May, when the Nile is at its lowest, the White Nile contributes 85 per cent. of the total discharge and the Blue Nile the remainder.

As already stated, our knowledge of the sources of supply of the Blue Nile is still scanty. The Rahad and Dinder come down from Abyssinia and join the Blue Nile respectively 120 and 150 miles above Khartoum; but both of these are dry in the summer and contribute only about one-



3. *Average discharges of the Nile during the period* 1912–26

thirteenth of its total supply. The portion which comes out of Lake Tana is also small, being a little more than one-thirteenth of the total discharge of the Blue Nile. Thus the greater part of its supply joins the river between Lake Tana and where it enters the Sudan, and hydrologically this part of the basin is unexplored (Plate No. 5).

From the point of view of irrigation in Egypt, the White Nile is more important than the Blue, and it is to conservation works on this river that Egypt must look for the full development of its cultivable land. The White Nile begins to rise in May, but the rapid rise of the Blue Nile by ponding up water in the White Nile valley above Khartoum prevents this rise from affecting the discharge of the main stream until later. A study of Fig. 3 will show this phenomenon. It has been proposed to build a dam across the White Nile about 25 miles south of Khartoum to store this ponded water and utilize it from February onwards to improve cultivation in Egypt.

The White Nile derives its supply in about equal parts from the Sobat and from the Lake Plateau. This is shown in Fig. 4, from which it will be seen that the Sobat is responsible for the greater part of the annual variation of the White Nile, which is due to the water received from the Abyssinian Plateau. A large part of the Southern Sudan is flat plain, and in flood-time the Abyssinian tributaries of the Sobat inundate large areas of country. This exercises a delaying action on the discharge at the mouth, which is at its maximum in November, three months after the maximum on the Blue Nile. The Sobat probably receives some water by way of the Pibor from the Lake Plateau, but nothing definite is known about this. In the high flood of 1917 practically the whole country between the Bahr el Gebel and the foothills of Abyssinia was inundated. In exceptional years like this, a good deal of water from the Lake Plateau must drain into the Sobat. The other branch of the White Nile, the Bahr el Gebel, draws most of its supplies from the Lake Plateau. Along this river for 370 miles north from Bor are the extensive swamps known as the Sudd Region. Here the river flows through an almost flat plain with many side channels and lagoons in the swamp, the extent of which depends upon the height of the river. As one goes through this region, there is nothing to be seen except papyrus and reeds and ambatch bushes, with occasional trees in the distance marking patches of higher ground. In places the river winds about considerably. Swamp continues to a less extent south of Bor as far as Mongalla. Some of the water which leaves the Bahr el Gebel drains into the Bahr el Zeraf, a parallel stream to the east which arises in the swamps and joins the Bahr el Gebel below them. The quantity of water leaving the Gebel has been increased by two artificial cuts joining the two streams. The Bahr el Ghazal is at present unimportant since very little of its water reaches the Nile. These swamps waste large quantities of water by evaporation and obliterate all minor fluctuations. A rise of the river

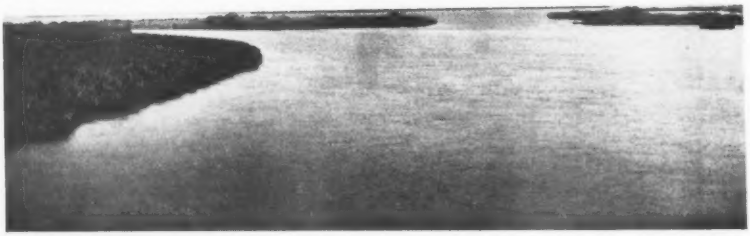
5. *The Dinder reduced to pools, as the Atbara and Rahad, at low water*

Phot. J. R. Herbert

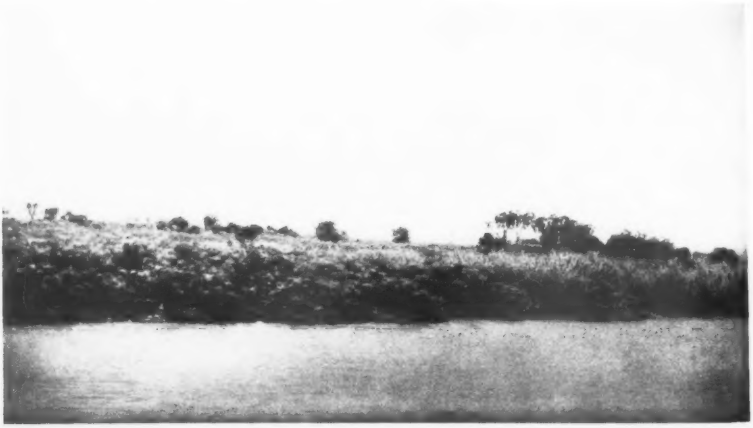
6. *Principal cataract of Blue Nile at exit from Lake Tana*

7. *Kodok (formerly Fashoda) on White Nile*

8. *Sudd block forming on the Pibor*



9. *Lake No at junction of Bahr el Gebel (left) and Bahr el Ghazal*



10. *Occasional dry ground in sudd region of Bahr el Gebel*

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upstream of the swamps has to fill them up all the way down before it can be felt at the tail (Plates 10, 11).

The lag introduced by this process between Mongalla and Malakal is three or four months, while the average loss of water due to the swamp is about 50 per cent. of that which enters. In very low years the loss and lag are less, because the swamps are of much less extent. It is only in recent years, particularly in 1922 and 1923, that it has been possible to study the river in this condition. For years investigations have been carried out on the Bahr el Gebel and Bahr el Zeraf by the Irrigation Service with the aim of producing a project to transmit the water without heavy loss through the Sudd Region, while at the same time retaining control so that the discharge of the Main Nile need not be increased at the top of its flood. The problem is a difficult one, and can only be solved by a large expenditure both on investigations and works.

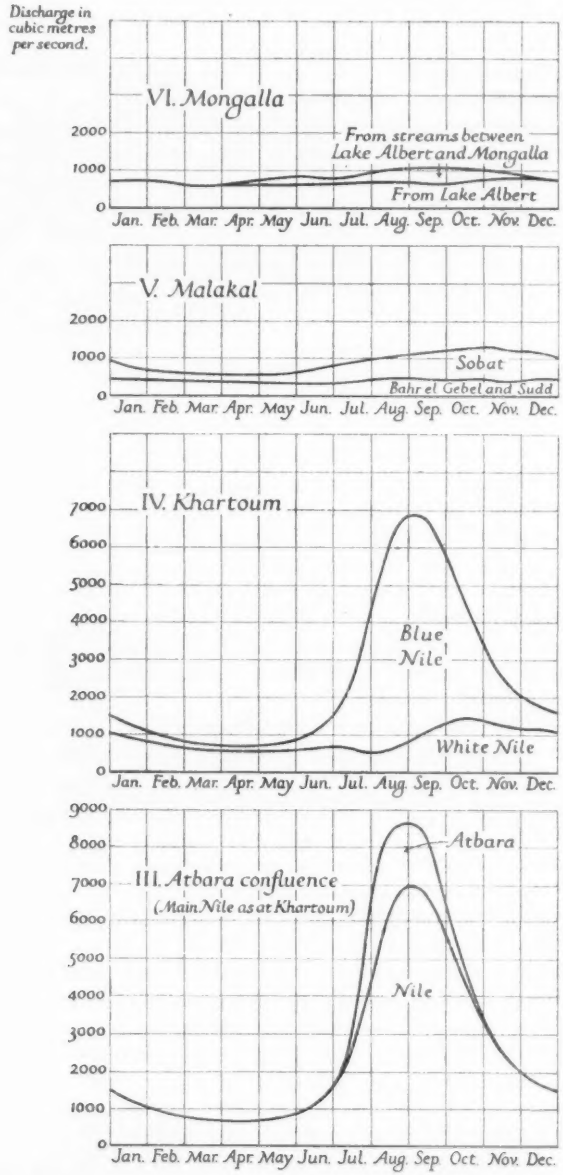
One cannot travel in the basin of the Upper Nile without being impressed by the important part played by vegetation in the *régime* of the river both in the Sudan Plains and in the high country of the Lake Plateau. At the present time experiments are being carried out upon the loss of water by evaporation from the swamp and its vegetation, and preliminary results show that it is rather more than twice that from open water. In my opinion it will be unsafe to carry out big projects in these swamps without first making a proper study of the habits and conditions of life of the vegetation.

Owing to regular traffic up and down the Bahr el Gebel it does not now become blocked with vegetation as it did previous to the re-occupation of the Sudan (Plate 8).

South of Mongalla there is practically no swamp, and the river soon becomes unnavigable owing to its passage through the hills and rolling country forming the slopes of the Lake Plateau. Our knowledge of the hydrology of the country south of Mongalla is still in the reconnaissance stage, and has not the precision of the work already described. Nevertheless a general description of the *régime* can be given, which will probably only be modified in details by future work.*

On the average, 80 per cent. of the water passing Mongalla comes from Lakes Albert and Victoria, the remainder being from small streams of a torrential nature which join the Bahr el Gebel between Rejaf and Lake Albert, and are practically dry except in the rainy season (Fig. 4). Rather more than half the water entering Lake Albert comes from the Victoria Nile. The Semliki river is the only other feeder of importance, and this comes down from Lake Edward. Very little is known about the hydrology of the Semliki or Lake Edward, and a gauge should be erected on the lake as soon as possible. Lake Albert is important because, owing to the small area of low-lying land on its shores, raising its level would not greatly increase the water losses due to evaporation.

* See Hurst, 'Report on Lake Plateau Basin of the Nile.' Government Press: 1925.



4. *Average discharges* 1912–26*: the upper curve giving the total discharge, the lower the contribution of the affluent named below it*

It could therefore be made into an economical reservoir, and is one of the sites to which Egypt must look for the water storage necessary for the full development of the country.

The Victoria Nile comes down from Lake Victoria through Lake Kioga to Lake Albert. Lake Kioga is a shallow lake with a number of swampy arms which receive drainage from the highland north of Lake Victoria and from Mount Elgon. It is almost certain that the action of Lake Kioga is to diminish the discharge of the Victoria Nile by evaporation in the lake during the dry season and to augment its discharge during the rainy season. A quantitative estimate of the losses and gains would however require much more information than is at present available (Plate 12).

Lake Victoria is an enormous lake whose main water-supply is the rain falling directly on its surface. The rainfall is practically equal to the evaporation from the lake, while the outflow from the lake into the Nile is on the average about one-fourth of the rainfall or evaporation, and is roughly equal to the water which drains off the land area of the Lake Victoria Basin. Less than 10 per cent. of the rain which falls in the Lake Victoria Basin drains into the lake, in spite of the fact that the country is hilly. This is due to the vegetation and to swamps in the valleys. These swamps are one of the most important factors in the hydrology of the Lake Plateau, and have also a local interest from the point of view of health and communications. If one of them were studied and observations made of the water-level, the water entering and leaving, and the water transpired by the vegetation, information would be obtained which would be of use if there is ever any question of draining or canalizing swamps, to say nothing of its scientific interest (Plate 14).

The only tributary of the lake of any importance is the Kagera River, and this has not nearly so large a discharge as was previously thought. Sir William Garstin * stated, " The discharge of the Kagera may then be considered as varying between 140 and 1500 metres cube per second." My own examination of the river last year leads me to think that this minimum is probably of the right order, that the maximum is very unlikely to pass 500 cubic metres per second, and that the mean discharge is of the order 250 cubic metres per second.† The Kagera is a rapid stream usually bordered by swamp and in places connected with large swamps and lakes (Plates 15, 16). Its discharge and those of its principal tributaries were measured last year at a number of points, and this was sometimes a matter of difficulty with the primitive boats available. The principal tributaries of the Kagera are the Ruvuvu and the Nyavarongo, which drain the Belgian territory of Urundi and Ruanda. This

* 'Report on the Basin of the Upper Nile' (Cairo Government Press, 1904), and Blue Book Egypt, No. 2, 1904.

† 'Report on the Lake Plateau Basin of the Nile,' Part II. Cairo: Government Press, 1927.

area is mountainous and includes some striking features, such as the Mufumbiro Range and some beautiful lakes. The Kagera is not at present of sufficient importance to necessitate detailed study, but it is hoped that the assistance of the governments of Uganda and Tanganyika may be obtained in collecting a little more information about its *régime*. A gauge near its mouth would give all the information easily obtainable at present. —

Lake Victoria.

On my recent journey I looked into two interesting questions. Professor Schwarz has put forward a theory that streams which rise near Lake Victoria and flow down into Lake Tanganyika will ultimately cut back and drain Victoria into Tanganyika. He also says that this process might be accelerated if an earthquake produced a suitably placed fissure. I examined the watershed to the south of Lake Victoria and found swampy valleys down which water makes its way in the rainy season, but no perennial streams. If there is erosion it is going on very slowly and need cause no alarm for thousands of years. Similarly, the chances of a suitable earthquake fissure are so remote as not to be worth considering. It may be noted that even if another Nile were opened up it would only lower the lake about 1 foot per annum, which would allow time for preventive measures before much harm was done.

South of Lake Victoria, starting from the head of Smith Sound there is a line of low swampy country, and water from this runs north into Lake Victoria and south-east into Lake Eyassi in the Rift Valley. In pre-war times there was a German scheme, though not an official one, for a canal along this line to take water from Lake Victoria to irrigate land to the south-east. As an engineering scheme this would be feasible, but from a financial point of view the profit would be doubtful, and as it would certainly lessen the flow of the Nile it would raise a very complicated question of water rights. In any case there is so much land in Tanganyika Territory which can be cultivated on the normal rainfall that it is very unlikely that large and costly irrigation schemes will be undertaken in the near future.

The Upper Blue Nile.

The remarks already made about the Upper Blue Nile will now be amplified a little. Any scheme for the complete utilization of the water of the Nile must involve a reservoir on the Upper Blue Nile, and for this Lake Tana has obvious advantages. Three missions have been up to the lake to investigate its possibilities as a reservoir, and the last one surveyed the outlet of the lake and the river for some distance below it. The discharge out of the lake was also measured regularly during this time and found to have an average value of about 140 cubic metres per second. As far as could be seen there is a constant relation between the level of the lake and the outflowing discharge, and this has enabled us

11. *A lower reach of the Bahr el Zeraf*

12. *Arm of Lake Kioga covered with water-lilies*

13. *Exit of White Nile from Victoria Nyanza at Ripon Falls*

14. *Typical valley swamp in Ruanda*

15. *Papyrus fringe of Kagera* 25 *miles above mouth*

16. *Falls of the Kagera below junction of Ruvuvu and Nyavarongo*

since the mission was withdrawn to estimate the discharge from readings of the lake-level made by an Abyssinian. Unfortunately, this source of information has come to an end (Plate 6).

The evaporation from the lake was observed and found to be on the average 3·6 millimetres per day, or about the same as that from Lake Victoria. The problem of measuring the evaporation from open sheets of water has not yet been completely solved owing to the fact that when floating tanks are used it is difficult to protect them against splashing in rough weather, and yet at the same time leave them freely exposed to the air.

Five-sixths of the Blue Nile supply enters it between Lake Tana and the Sudan Boundary. In this portion of its course the Blue Nile is in a deep valley, which has never been completely explored owing to its rugged nature, which has prevented travel along it. It is known that the Dabus and Dadessa, which enter the Blue Nile within 100 miles of the Sudan Boundary, are important streams, but we know nothing about their discharges, or about those of any other of the southern tributaries of the Blue Nile. A reconnaissance of the Blue Nile between Lake Tana and the Sudan Boundary should be made as soon as possible, in order to discover the relative importance of its tributaries and where its supplies come from. This would be a heavy undertaking, and could only be done at low stage. However, measurements of the low-stage flow combined with a careful examination of the river valleys would give a general idea of the relative importance of the various tributaries. The low-stage discharges of the Blue Nile and its tributaries are much more important than the flood discharges. This is fortunate, because it may not be possible except at a prohibitive expense to measure flood discharges. For these a launch is necessary, and the nature of the river is such that the launch would probably have to be brought on mule-back and erected at the discharge sites. In any case the measurement of a big rapid river is a difficult and dangerous piece of work.

It has been suggested by Mr. H. T. Cory that as a scheme for a high dam in the Colorado Canyon is under consideration a similar scheme might be possible in the Blue Nile Canyon. This would be a point for a reconnaissance party to investigate.

Other Studies.

The Sudan Survey was founded in 1905, and the last twenty years have seen the construction of maps of most of the Nile Basin. There are, however, still portions of the basin which are very little known and of which reliable maps do not exist, as for example portions of the Sobat and Bahr el Ghazal basins and most of the Blue Nile Basin in Abyssinia. In Uganda and Kenya the basin is well mapped, but the pre-war German maps of Tanganyika leave much to be desired. First-order levelling exists from the sea to Wadi Halfa. From Halfa to

Khartoum there is second-order levelling, and from Khartoum to Lake Albert there is again first-order levelling, with a branch line up the Blue Nile to Roseires and side lines of second-order work in the Sudd Region. Nearly all the principal river gauges of the Nile system are connected up with this levelling.

One of the important practical questions of hydrology is that of forecasting the probable flow of the Nile which will enter Egypt. These forecasts are of two types : those based upon a knowledge of the *régime* of the river in past years, and those based upon empirical connections of Nile flow with meteorological phenomena in other parts of the world.

The first type of forecast has been successfully developed, and is a routine proceeding during the falling stage of the river after the flood has passed. It depends on the fact that the river usually falls steadily from November to May, so that during this period conditions in one month largely determine those in the following months. Forecasts for short periods ahead can be made with good precision from a knowledge of the discharges in the upper parts of the basin, and previous experience of the lags and losses in transit. Forecasts made in this way are of considerable importance in the last stages of filling and emptying the Aswan Reservoir. The second or meteorological type of forecast was developed by Sir Gilbert Walker in India for predicting the Monsoon. Before the war a good deal of work had been done by Lyons,* Craig, and myself in investigating correlations of meteorological phenomena with the Nile Flood. On taking up the work again later it was found, after bringing the computations up to date, that most of the correlations had weakened. Sir Gilbert Walker and his assistants have investigated a large number of these meteorological correlations and found some new ones for the Nile Flood,† but up to the present in the case of the Nile no such prediction has been evolved which is good enough for any practical purpose.

There are several reasons for this failure. One is that meteorological events like the Nile Flood are usually complicated and do not depend on one or two causes only. Thus, when two or three phenomena have been found which are related empirically to the Nile Flood there is always a fairly large residual effect which possibly depends on a number of causes all producing small effects. The smaller the effect produced the more difficult it is to discover the relation and the larger the unavoidable errors. Hence it becomes impracticable to employ a formula involving more than three or four phenomena.

Another difficulty is that long series of observations are required for investigations of this nature. We have now continuous records of Nile levels extending back for nearly sixty years, but sets of meteorological

* Lyons, ' Physiography of the Nile.'

† Walker, Indian Meteorological Memoirs, vols. **23** and **24**. ' Correlation in Seasonal Variation of Weather.' Bliss, ' Nile Flood and World Weather,' Memoirs Royal Meteorological Society, vol. **1**, No. **5**.

observations which have been carried out under unchanged conditions for such a period exist only for a few stations. A third difficulty is that relations between meteorological phenomena sometimes persist for a number of years and then apparently disappear.* This means that the real relation has not been discovered, and these discontinuities will be liable to appear as long as the relations are purely empirical and their mechanism is not understood. There is hope, however, that a study of the motion of the upper layers of the air in conjunction with the surface conditions over Central Africa may enable us to discover the factors which regulate the rainfall of the Nile Basin and where the water comes from.

This work will require the accumulation of observations over a number of years. Consequently the sooner we start systematic collection the sooner are we likely to solve the problem.

The most likely theory at present is that the rains which fall in Abyssinia and cause the Nile Flood come across Africa from the South Atlantic Ocean.† To investigate this properly we shall require the collaboration of meteorological services in the Belgian Congo and West African States, and ultimately perhaps conditions in the Antarctic Ocean may be found to play a part through the Benguella Current up the West Coast of South Africa.

Since 1900 meteorological stations of a standard type have gradually been established over Egypt and the Sudan, and are controlled by the Physical Department. Other stations exist farther south, and there is under consideration at present a project for forming an East African Meteorological Service on the same lines as that of Egypt and the Sudan, some of its cost being contributed by Egypt.

All the streams coming from Abyssinia carry silt when in flood. The silt carried by the Blue Nile and Atbara has formed the cultivable lands of Egypt, and is still extending the Nile Delta seaward. The maximum content of silt in the water passing Aswan is between 2000 and 3000 parts per million, but the amount varies from flood to flood. It is on account of this silt that the flood water cannot be stored, as much of the silt would be deposited in the reservoir. An account of the chemistry of the Nile water was published in 1908 by Mr. A. Lucas.‡ Since that time much work which needs to be collected and summarized has been done on the Nile water, silt, and soils by many authors. Monsieur Victor Mosseri, who has done much of it himself, is at present engaged upon this summary. Very little has been done in Egypt on what might be called the physics of silt deposition. This is an important question in connection with canal

* Mossman, "Southern Hemisphere Seasonal Correlations" (*Symons' Meteorological Magazine*, vol. 48, 1913).

† Craig, "England—Abyssinia—The South Atlantic: A Meteorological Triangle" (*Quar. Jour. Roy. Meteorological Soc.*, vol. 36, 1910).

‡ Survey Department Paper No. 7. Cairo: Government Press.

design, as every year large sums of money are spent in clearing silt deposits from the canals in Egypt. It has been recently taken up by Mr. A. D. Butcher.

Within the last few years H.H. Prince Omar Toussoun has been collecting geographical information from old writers about Egypt and the Nile, and has published this in the Memoirs of the Institute of Egypt.* In particular there are several volumes on the history of the Nile in which one of the most interesting features is a collection of gauge readings for the Nilometer on the Roda Island, Cairo. The Nilometer dates from soon after the Arab invasion of Egypt, and is perhaps the oldest Arabic monument in the country. It is not known what became of the original records, but Prince Toussoun has collected from various writers, mostly Arab historians, a series of the maximum flood readings from A.D. 621 to A.D. 1921, from which only 192 floods are missing. Some of this material has been analysed for periodicities † by J. I. Craig, Professor H. H. Turner, and C. E. Brooks, but no periodicities of large enough amplitude to be of practical importance have been found. The periodicities found are obscured by irregular variations, and the only general conclusion is that there are fairly long intervals of time when floods tend to be high, but during such intervals low floods may occur. In recent years we have been in an interval when floods have tended to be low. In the thirty years preceding 1900 there were fifteen years with floods higher than anything which has occurred since.

The frequency distribution of the heights of the floods recorded on the Roda Gauge has been plotted ‡ and found to follow very closely the normal law for the occurrence of departures from the average. Dr. Phillips has been recently examining the records of Roda (Cairo) Gauge, and finds that the continuity in modern times is often doubtful. In the *Journal* of this Society for 1889, Colonel Ardagh expressed the same opinion. It is therefore necessary to use the old records with caution, remembering that changes of the gauge may have passed unrecorded, and that as the assessment of taxation depended on the height of the flood, the recorded height in some cases will certainly differ from the actual. On the whole the records will probably give a general idea of the succession of high and low floods.

Mr. C. E. Brooks § has recently found a high correlation between the levels of Lake Victoria and sunspot numbers. Since sunspots are periodic, this implies a periodicity in the levels of the lake. Unfortunately the records of the lake-level only extend back for about thirty years, covering a little less than three periods, and I am doubtful if this is long

* ' Memoire sur l'Histoire du Nil,' Memoires de l'Institut d'Egypte, 1925.

† Prof. H. H. Turner, " Note on the 240-year period in Chinese Earthquakes," *Mon. Not. R.A.S.*, May 1919 and April 1920.

‡ Sir M. MacDonald, ' Nile Control,' p. 36. Cairo: Government Press. 1920.

§ ' Variations in the levels of the Central African Lakes ' (Geophysical Memoirs No. 20). Meteorological Office, London.

enough to say that the connection is not accidental. In addition, it should be pointed out that the correlation which would be expected if the connection is a direct one, is that between sunspot numbers and rate of change of lake-levels. The coefficient of this correlation is practically zero.

Further information on hydrological questions is to be found in Reports on the Nile Flood and the Rains of the Nile Basin published by the Survey of Egypt and later by the Physical Department, and in other papers of these Departments and the Irrigation Department.

I have said little about the projects for the extension of irrigation nor of the question of equitable distribution of water between Egypt and the Sudan, because these are practical applications of hydrology outside the scope of my paper. Neither have I said anything about the Nile Projects controversy because it contributed nothing to scientific hydrology.

Information about these subjects will be found in Sir M. MacDonald's 'Nile Control' (Cairo, 1920); Report of the Nile Projects Committee (1919); Report of the Nile Projects Commission (1920); C. E. Dupuis' 'Report on the position and activities of the State Service of Irrigation,' etc. (Cairo, 1925); and the Annual Reports of the Irrigation Department.

Conclusion.

I shall conclude by summarizing the work which it is important to continue and that which should be undertaken without delay.

It is clear that the future increase of the population in Egypt and in the rest of the world will ultimately demand that the cultivable lands of the Nile Basin shall be developed to their fullest extent. This can only be done by big projects which will modify the whole *régime* of the river. Some of these works will be on the headwaters of the Nile outside of Egypt and the Sudan, and will require the co-operation of other states. The construction of these works will be sure to conflict in some ways with local interests, but there is no doubt that in the long run they will be advantageous to the countries in which they are built, inasmuch as they will assist in their development financially and in other ways. Every new work will complicate the control of the river, and its regulation will require the fullest use of hydrological data.

It is therefore necessary to continue the present observations and to extend them to Abyssinia and the Lake Plateau of Central Africa, and to finish the reconnaissance of the basin. Here again the assistance of the Governments of Uganda, Kenya, Tanganyika, the Belgian Congo, and Abyssinia will be required. Although these studies will be undertaken mainly in the interests of Egypt and the Sudan, they will inevitably produce material of local interest in connection with navigation, power schemes, meteorology, agriculture, and public health. There is therefore no doubt that the various states will give facilities for study in their

territories as they have in the past, and will themselves co-operate more and more in the future.

It may be pointed out that while the rate of construction of maps depends mainly on the number of the staff employed, the collection of hydrological information must be spread over a number of years if it is to be properly representative.

A study of the life-habits of swamp vegetation is indispensable in connection with conservation works in the Sudd Region.

Forecasts of the Nile Flood are becoming more and more important as more and more of the Nile water is required for irrigation purposes. For long-distance forecasts our only hope is the development of meteorology, which is thus becoming more and more important in the study of the Nile, and it is to be hoped that in the near future the African continent will be covered with a network of meteorological stations where really reliable observations are made, and that at selected stations the study of the upper air will be commenced.

In conclusion, I should like to thank Mr. Hinks for a number of suggestions for additions to this paper.

Before the paper the CHAIRMAN (Sir PERCY COX) said: The paper we are to hear to-night is by Dr. Hurst, who is Director-General of the Physical Department of the Ministry of Public Works in Egypt. He has been in the employ of the Egyptian Government for many years; is responsible for hydrological records on the Nile; and two years ago went on a mission to the Upper Nile to examine the situation there. You are all aware that the question of the adequate water supply in Egypt depends in a great measure on the waters of the Upper Nile, and there are several very difficult and important problems connected therewith. We hope to hear from Dr. Hurst an explanation of the various aspects of these problems and the progress of the last twenty years as well as of the possible lines of progress in future.

Dr. Hurst then read the paper printed above, and a discussion followed.

The CHAIRMAN: We are fortunate in having with us several gentlemen who have made their mark in various aspects of Nile hydrology: Sir Henry Lyons, the present Director of the Science Museum, formerly Surveyor-General in Egypt and author of the masterly work to which the lecturer referred; Sir Murdoch MacDonald, whose name is one to conjure with in connection with Nile irrigation; and Dr. Simpson, formerly Director of the Meteorological Department of the Government of India and Director of the British Meteorological Office for some years past, who was on a mission to Egypt in regard to meteorological aspects of Nile hydrology and also has experience of the rivers of Mesopotamia. All three ought to have interesting observations to make upon the lecture. I will call first upon Sir Henry Lyons.

Sir HENRY LYONS: I am sure we have all heard with very great interest the modestly worded address that Dr. Hurst has given to us, sketching out the results obtained from a large amount of accurate and detailed work extending over some fifteen years or so. If any one will take the trouble to glance at those papers of 1908 and 1909 to which he referred and compare them with the paper by Dr. Hurst which will appear in the *Journal*, it will be seen that then

much was a matter of conjecture, of tentatively anticipating that this or that might be the case, whereas to-day the Governments of Egypt and the Sudan have in their hands a vast amount of accurate and precise material as the basis of work to be carried out by the irrigation engineer; a very different position from that of their predecessors twenty years ago. I am sure that it is not only of great assistance to them but is also a thoroughly economical proposition for such hydrological investigations to be carried out wherever it is possible, and their value cannot be overestimated.

Dr. Hurst referred in passing to the fact that for a considerable period of the year little water is flowing down the branches of the Nile through the Delta. Very few people in this country realize that from, roughly, the middle of February to an early date in August the whole of the water that passes Cairo is conveyed by canals on to the cultivated ground; and to direct and control the irrigation of a vast area like the Delta from day to day means that a very large amount of accurate observation and measurement must have been carried out as the basis of it. I think I am not far wrong in saying that there is no river in the world that is at the present time so accurately gauged, of which its *régime* is so thoroughly known, as that of the Nile, and this both those who have to distribute those waters and geographers who are interested in these matters owe to Dr. Hurst and his staff of the Physical Department in Cairo.

Sir MURDOCH MACDONALD: I listened as an engineer, not only with pleasure but with intense interest to what Dr. Hurst told you. My predecessor in speaking said that hydrology and statement of fact might appear somewhat dry. They certainly do not do so to me, nor do I imagine for a moment you would have given such intense attention to the lecture had you not appreciated the same point of view. I am interested, of course, as an engineer. Dr. Hurst and the hydrologists look at these figures as records. I think of them, on the other hand, from the point of view of what the results of these figures put into the hands of engineers will be, and undoubtedly from that point of view they are of the very deepest interest, not only to Egypt, but to the Sudan.

I think Dr. Hurst said that in the matter of investigating future water supply, it would be desirable to know as long as possible beforehand the height of the coming flood. I am not quite sure that as an engineer I agree with him, because I believe that Dr. Hurst himself has investigated past years' records of the Nile gauge which show the height of the flood from 640 A.D. to the present day—nearly 1300 years—and if you deduct 200 unrecorded years you still have 1100 years' records. In all those records, as far as I know, there has been no flood so low that with the present and immediately prospective methods of regulations in Egypt, the country cannot in flood time be fully supplied with water. An entirely different situation, however, arises at the other time of the year. In summer Egypt has never since she adopted perennial irrigation, about 100 years ago been adequately supplied; and even to this day there are large areas of Lower Egypt still uncultivated and for which she would like to have water. It is consequently necessary to store water so that there may be a greater supply to distribute. At Nag Hamadi, a point below Aswan, a barrage is being built by the Egyptian Government which will enable the country to be fully supplied in flood time, but additional conservation of water for summer is necessary and is under consideration. As the particular method however is still *sub judice*, I will not refer to that scheme, but would draw attention to what Dr. Hurst has said.

He has told you that there is a vast area—I think he said from Malakal to

Bor—consisting of some 370 miles in length of a practically dead flat plain with the river flowing through it. He added that when you stood on the top of your steamer and looked across country on either side you could see no hill country at all. We know, as a matter of fact, that there can be very little ridge, if any, between the Bahr el Jebel and the Sobat river. If the area is some 370 miles by 200 or 300 miles it is a vast plain in which an enormous amount of water is being lost. Here is a possibility of conserving water. I do not think that future mankind will permit so vast a plain to be left for all future time as a wasteful marsh. There are two things which might be done in order to get the water out of it. The river itself might be dredged to some little extent and banks thrown up on either side, so that the water coming down from Mongalla and farther south could be run through it without serious loss. The water would always be above the level of the land, and the land itself would be still water-logged and unsuitable for cultivation. Then there is the possibility of lowering the river-bed from Khartoum all the way south to Bor. If that were done no great lowering would be required, because the swamp region, as you saw from the slides, is no more than a foot or two, at the outside, under water. Therefore the simple lowering of the river by, say, 6 feet at Malakal, so that the river would flow at a deeper level in its bed, would drain the whole of this vast area, and I suggest to Dr. Hurst that in any future investigations he should keep such a possibility in mind, so that the water supply of both Egypt and the Sudan would be fully considered from that point of view. In any case the populace both of Egypt and the Sudan is increasing very rapidly and further outlets are required. Here, undoubtedly, is a vast area which in the future ought to be brought in for the benefit of mankind.

I have listened with pleasure to Dr. Hurst. I have known, naturally, a little about these matters, and I am particularly glad to say that there is now a dam on the Blue Nile at Sennar. It was built to irrigate 300,000 acres by water taken out of the Blue Nile in such a way that it would not decrease Egypt's supply. I am glad to understand that more recently it has been found that the area can be increased to 420,000 acres, still without damage to Egypt.

I do most sincerely congratulate Dr. Hurst on his excellent address. I have seen a proof of it. I am personally able to say that it contains most valuable matter for the benefit of mankind. I hope the Sudan Government, and more particularly the Egyptian Government, and not only they, but the British Government and the British Empire as a whole will realize that there is a very valuable work for the world being done through the instrumentality of such men as Dr. Hurst by the experiments and observations which he has been making on the Nile.

Dr. G. C. SIMPSON (Director of the Meteorological Office, Air Ministry): I must, first of all, express my personal pleasure in having heard Dr. Hurst's address. Some years ago I had the satisfaction of going up the Nile and examining the data of which he has spoken to-night in considerable detail, and I found them extremely fascinating.

I would like to say something on the meteorological problem because, when all is said and done, if there were no meteorology, Dr. Hurst would have no water. In any case, it is obvious that the problem of the supply of water is primarily a meteorological one, and I regret very much that the irrigation engineers appear to consider it only a meteorological forecasting problem. There are several methods of approaching this problem.

In the first place, we can work out the physics of why the rain falls at all. It is not an easy matter to decide why it is that there is rain in the Abyssinian

Hills which supplies the water in the Nile. As a matter of fact, I think it was men sent out under Sir Henry Lyons, at all events men of the Egyptian Survey, who have determined that the water which falls on the Abyssinian Hills all comes out of the Atlantic. A kind of monsoon blows a south-west wind from the Atlantic side of Africa, and the rain-bearing clouds come right over the plains of Central Africa, and when they meet the highlands of Abyssinia the air is forced to rise and deposits its rain on those hills. We thought originally that it was part of the Indian monsoon, but now we know this water which actually runs down the Nile has been picked up very largely out of the Atlantic Ocean. In this way we have obtained some knowledge as to the cause of the rain, and therefore the first step towards forecasting.

The second method is one of which Dr. Hurst spoke, developed in India by Sir Gilbert Walker, of trying to find out relationships between the conditions which exist in the world and the rainfall which falls in different parts. Sir Gilbert Walker was, of course, interested particularly in the monsoon of India, and he finds that, if he examines the pressure in South Africa and the temperature in Central Australia, and factors of that kind, he is able to get some forecast, some idea of what the monsoon and the Nile flood is going to be. That is all statistical work which needs a tremendous amount of information before it is possible to apply it, but it has been applied to the monsoon and, to some extent, it has been applied to the Nile. The success has been mainly scientifically, for the forecasts are not yet sufficiently definite to be of much practical use.

There is another method which I think has not yet really been tried. We have the records of the Nile flood for over 1000 years, and if we plot them we find that there are successions of years in which there is high flood and then a succession in which there are low floods. Sometimes there is a period of about twenty years of low flood; then there is probably one hundred years of high flood. People have searched the record for periodicities; in fact, the idea of a period seems to be ingrained in some people, and they always look for periodicities, but I think that we have not got to examine those long records for periodicities, but to pick out those chunks, as it were, of high water and those chunks of low water, and thus find out—it may not be terrestrial, it may be something astronomical—why it was that for twenty, thirty, or one hundred years there was a tendency for low water and in another period a tendency for high water. As far as I know, nobody has yet attempted to find out the physics of these long-period changes. We can see the same sort of changes in what are often called changes of climate when parts of the world now deserts have had vegetation upon them—I am not talking of the Ice Age, but of changes more recent than that. Such changes are very small expressed in degrees of temperature, or in quantities of rainfall, but very real in their cumulative effect. But in order to investigate that we must have very accurate observations. We want, in fact, two kinds of observation, meteorological and hydrological. In Egypt the measurements of the water in the Nile leave nothing to be desired. I do not think that they will ever be improved upon; they may be extended, but I cannot imagine how they can be improved. We have a good deal of meteorological information, but not sufficient, especially in the region in which Dr. Hurst is particularly interested, and it is good to know that Dr. Hurst has quite recently, while he has been on the expedition of which he has told us, tried to encourage the authorities in Uganda and Kenya and surrounding countries to start a meteorological service for East Africa. That is the way in which in a certain number of years—probably when we are all gone—there

will be accumulated data which will make it possible to solve the problem, and to use that long series of data to give us a complete history of the Nile.

Mr. C. F. REY: Dr. Hurst drew particular attention to three points in connection with the Blue Nile and its bearing upon the water supply of Egypt and the Sudan. He said first that very little was known about it. In the second place, he pointed out the very large amount of water which it contributed to the general supply of Egypt and the Sudan. I think the figures on the map showed something like twice as much from the Blue Nile as from the White Nile above Khartoum. He also pointed out that in time to come with increased population and the consequently increased necessity for irrigation very much larger quantities of water will be needed for irrigation. I would like to amplify those three points a little.

To take the last point first: the Blue Nile sends down a large volume of water just at the very time when it is not wanted. During the months when the water supply is lowest in Egypt and the Sudan the water coming down from Lake Tana through Abyssinia is at its lowest. At other times when water is plentiful Lake Tana through the Blue Nile sends down large quantities which run to waste, to a certain extent. There is no doubt that the water which comes down the Blue Nile does not come altogether, or indeed mainly, from the lake. It must come down from some of the tributaries which run into it below the lake. Very little is known about these or about the rivers. I have crossed during the dry season some of these larger tributaries, and at the very height of the dry season they were sending down a plenteous supply of clear water in marked contrast to the Rahad, Dinder and Atbara which Dr. Hurst said at the dry season send down practically none at all. Therefore it seems to me that the problem of assisting the water supply of Egypt and the Sudan from Lake Tana and through the Blue Nile is one which demands the most careful investigation before it is finally decided that the best place to tap and store that supply is right up at the top of the river, namely, by the lake. It might yet be found that, owing to this large amount of water coming in from lower down the river through its tributaries, it is preferable to store water, provided a suitable place can be found, lower down towards the Abyssinian frontier. I will not, of course, refer to the political difficulties which have arisen in connection with the question of damming the river or the lake. I am speaking only from the point of view of the practical aspects of the case, and I think that that is a point which is well worth considering. Before, of course, anything of that sort can be done, or even considered, a great deal more information will have to be obtained about the extraordinarily difficult valley of the Blue Nile. At one of the places where I crossed it the river ran some 3500 feet below the escarpment, and for several hundred miles it runs through country of that sort. The place where I crossed then was, I believe, not previously known, though other crossing places are. It seems to me from the geographical point of view, with which this Society is mainly concerned, as well as from the hydrological point of view, that this matter will repay further investigation. If that is undertaken a good deal might be discovered which would help to solve the problem of increasing the water supply of Egypt and the Sudan.

There is one other point I would like to mention: the very great advantage which the country primarily concerned would derive from damming this water supply, supposing the dam were placed high up as at Lake Tana. In the first place, there would be no danger of the erection of such a dam resulting in flooding the country. Quite the opposite effect would be produced. The idea is to lower the sill by which the water escapes from the lake into the

Abbai. Consequently there would be no question of flooding shrines and holy places as the winter flood-level of the lake would not be raised at all above the present winter high-water mark. On the other hand, the lower and slightly increased range of levels would be a marked benefit to the surrounding population of the lake district because it would make it very much healthier by draining the marshes at present round the lake which make it so extremely unhealthy now both for man and beast. From those two points of view it may be said that the project would be a definite advantage. It would not raise the level of the lake, but would prevent floods and, at low level, drain the marshes; and thirdly, from the point of view of the population surrounding the district it would naturally increase their wealth and trade as a result of the money spent in the country. From the Abyssinian point of view, therefore, as well as from that of the water supply of Egypt and of the Sudan, the project could only be of benefit, and is therefore well worth considering as well as on purely geographical grounds. From the last-named point of view much valuable knowledge awaits the explorer of the upper reaches of that fascinating river, the Blue Nile.

Mr. E. B. HADDON: I had the great good fortune some years ago to meet Dr. Hurst in Uganda, and we had opportunity and leisure to discuss this very big question. I am an Administrative officer, and thus not very competent to speak on so technical a subject. Whether there is or is not a periodicity in the rise and fall of the lakes there certainly does seem to be some relation with famines, the famines following close on high water. These famines are probably better named food shortages, and appear from unscientific observation to be rather the cumulative effect of a succession of poor seasons than of a total failure in any one season. We have statistics of the rises with what appears to be a ten-year periodicity of high level in the lakes, and we have also records of food shortages. What connection there is between the two it is at present impossible to determine, but actually at the time when I left the country we found the lake was again rising, and there were signs of an approaching food shortage. Normally one thinks the more the rain the more the food. I venture to suggest that there may be differences in the distribution of the rainfall, with perhaps no great differences in the total fall for the year, and that this may be the connection between the level of the lakes and famine.

The rise and fall of the lakes is of course very important for us. Take, for instance, Lake Kioga; sometimes the ports are flooded out; at other times the water is so low that the steamers have to be unloaded far from the port. A few years ago Kioga seemed to form an ideal link in the transport system, and good roads were made to it. At that time the lake was high, but when it fell, produce had to find other routes. I have often wondered if something could be done to stabilize the lake-level.

It is really important to study this subject, and the impetus that Dr. Hurst has given is very welcome in our part of Africa. I feel that in solving the larger problems of water for Egypt he will solve the lesser but none the less vital questions which puzzle us in Uganda.

The CHAIRMAN: We have had a most instructive and interesting lecture and an extremely interesting discussion. Most of us who are probably not experts in hydrology realize the magnitude and diversity of the problems involved in the subject of the lecture to-night. I know very little of the Nile, something of the Tigris and the Euphrates, and I see that the problems are, in some measure identical, and in other respects entirely different. But one thing, I think, stands out in Mesopotamia, and obviously it is the case with the Nile also, that whatever projects are undertaken must be considered from the top,

and there must be co-ordination with all parties and all interests concerned. Once you begin tinkering with some small scheme without cohesion, you will find that your scheme reacts on some other portion of the river in a way which you did not anticipate. I entirely endorse what has been said as to the extreme importance of getting all interests involved to co-operate in one large measure of control.

I think we must realize, from the fascinating pictures shown us and some of the illustrations of the methods employed, that the lecturer was extremely modest in regard to the physical difficulties involved in the operations of river-gauging. It is so often the case here. Lectures are quite silent or colourless on questions of human endurance and privation; but what a great deal often lies behind what we hear from the lecturer himself! I am sure that is so in this case. We owe a debt of thanks to Dr. Hurst.

His Excellency Azziz Izzet Pasha, the Egyptian Minister in London, is here and has been good enough to ask to propose a vote of thanks to the lecturer.

The EGYPTIAN MINISTER: I am very much honoured to be called upon to say a few words at this most interesting meeting on the Hydrology of the Nile. I must thank you most sincerely for your kind invitation to me to be present this evening and of thus having given me the opportunity of listening to a most interesting and instructive lecture from which I have derived considerable information. I may assure Dr. Hurst that I am voicing the sentiments and the feelings of my country when I say that Egypt has always been grateful to those who have helped her. I am very happy to see several of them present here to-night, foremost amongst them Lord Edward Gleichen, Sir Henry Lyons, the eminent Sir Murdoch MacDonald, who has occupied the post of Under-Secretary of State for Public Works, and I dare say several others whom I do not recognize for the moment but to whom Egypt is gratefully indebted. I have nothing to add after what the eminent lecturer has said; therefore I have great pleasure in proposing a hearty vote of thanks to him.

DISCOVERY OF A GREAT RANGE IN NORTH-EAST SIBERIA

Sergei Obruchev

The bare facts of this discovery were noted in the Journal *for October, from a brief account in the* Zeitschrift für Gletscherkunde. *We are indebted to the discoverer for communicating to us the following more complete account of his important journey.*—ED. *G.J.*

IN 1926 I was charged by the Russian Geological Survey with the investigation of the north-eastern part of the Yakutsk region. The area to be investigated was to the east of the Lena river, between the latter and the Indigirka river. East of the Lena river there is a vast region extending for 3000 km. to the Bering Strait. This is drained by three great but little-known rivers: the Yana, the Indigirka, and the Kolima, each from 1500 to 2000 km. long. Of these rivers only the Yana and the lower course of the Kolima have been studied to any extent, while the Indigirka has remained absolutely unexplored. The few

1. *Mount Chun* (3300 *m.*), *Cherski Mountains*

2. *Crossing a taryn in the Iniali valley*

3. *A Mountain on the Indigirka*

4. *Lake Cherniai, Cherski Mountains*

5. *A Taryn in the Mirule valley, Cherski Mountains.* 18 *September* 1926

6. *Peaks on the Mirule, Cherski Mountains*

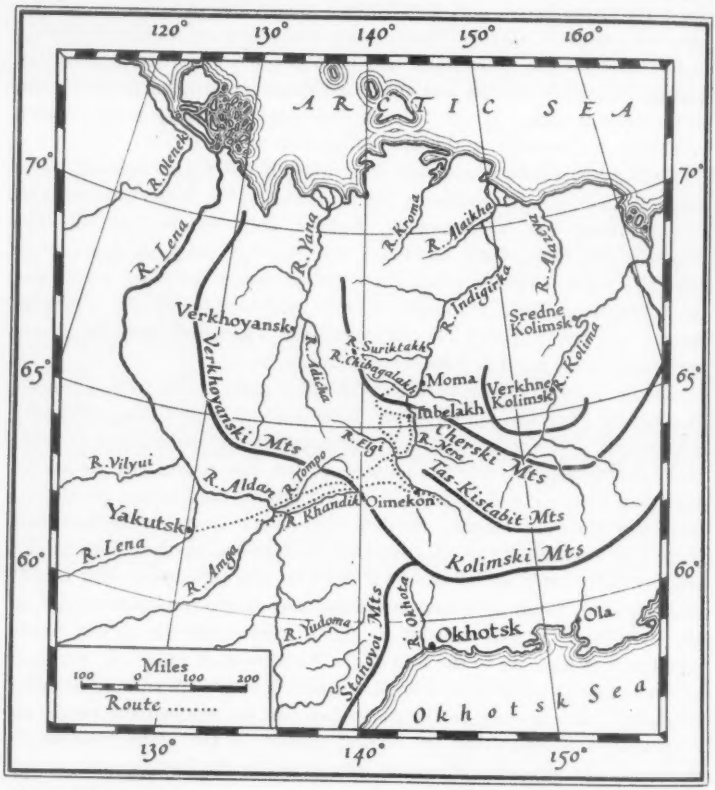
expeditions that have investigated this region started from Yakutsk towards the Yana, and from the town of Verkhoyansk on that river continued to the east towards the town of Sredne-Kolimsk on the Kolima river. The geologist Cherski alone passed in 1891 from Yakutsk eastward to Oimekon in the upper course of the Indigirka and thence north-eastward towards Verkhne-Kolimsk. A three years' investigation of all the three rivers was a part of Cherski's object, but in 1892, the second year of his work, he died of inflammation of the lungs near Nijne-Kolimsk. Before Cherski the same route had been covered 150 years ago by the traveller Sarichev, but his memoirs scarcely present any scientific interest at the present time. We had thus to investigate a region equal in area to France or Germany, and entirely unknown so far.

Before our explorations, the orography of the region seemed to be characterized by the following main features: a high mountainous arc—the ranges of Verkhoyansk, Kolima, and Anadir bordering the region on the west, south, and east; the Stanovoi range joining the arc from the south; on the north three radial chains radiating within the arc between the Yana, Indigirka, Kolima, and Omolon rivers. Of these ranges the range Kekh-Tas, between the Yana and Indigirka, was considered the wildest and most inaccessible.

In the middle of June 1926 our exploring party set off from Yakutsk. It consisted, besides myself, of my three assistants (a mining engineer, a geodesist, and a technician) and eight workmen. As we had to carry with us not only the complete equipment but also provisions, not knowing whether any could be had on the Indigirka, the caravan comprised forty-four horses. Having reached the Aldan river we learned that there was no direct way to the north-east as far as the Chibagalakh river, which was fixed as the final point of the expedition, and that it was necessary to go by a long circuitous way across the upper course of the Indigirka. It was difficult to find a guide even for such a route. The first 150 km., up to the foot of the Verkhoyansk range, lay through an area entirely covered with bogs in which horses were sinking at every kilometre. It was only on the ninth day that we reached the range, an enormous wall separating the coldest portion of the globe from south Yakutsk. At the place where we intersected it, the Verkhoyansk range consists of four parallel chains, of which the main one attains 2500 m. in height and is covered with patches of permanent snow. The south-western slope of the range facing the Lena and Aldan rivers has an alpine character, due to intense erosion; the slope facing the Yana and Indigirka is gentle, with a number of small chains, and has the aspect of a high plateau. The greatest width of the range at this place is 450 km., and we only reached the Indigirka river at the mouth of its great left-bank tributary, the Elgi river, by the beginning of August.

Thence we had to strike north, but it was found that there was no route along the Indigirka, and that only after passing more than 200 km.

on the ranges of the left bank would it be possible to reach the river at Tubelakh. The caravan of the exploring party, headed by my assistant-engineer Protopopov, was dispatched by this route, while I managed to get two Yakut canoes and, with our folding boat, to sail down the Indigirka river. According to the existing descriptions of Yakutsk based on verbal information obtained from natives, the area to the right



North-East Siberia, from the sketch-map supplied by the author. Spellings of names have been slightly revised to the system of the P.C.G.N., but the adjectival forms of Range-names and other divergences from our normal usage, have been left as the author used them

of the Indigirka was a vast lowland, and only to the left of the river were there mountains, offshoots of Kekh-Tas. But quite unexpected discoveries were in store for us from the very first day of our journey: instead of low banks we encountered high mountains, and the Indigirka intersected

a succession of lofty alpine chains covered with permanent snow. Some of the chains were 3000 m. high. The Indigirka crosses them by a narrow valley, or often by gorges. Here it is already a great river, having a width at narrow places of 600–800 m., and in widenings, with islands, to 3–4 km. But it still has a character of a mountain river, the velocity of the current attaining in places 15 km. and never falling below 6 km. North of Tubelakh the Indigirka river cuts one of the main chains of the region, and for a distance of 100 km. flows in a narrow tortuous gorge with many cataracts. From want of time we were unable to study this interesting place. North of this chain the Indigirka is navigable: the first trial was made in 1926 by the State Eastern Trading Company (Dalgostorg); two small barges of 40 tons each were floated from Moma to the mouth of the Indigirka.

After Tubelakh we had once more to turn aside from the gorge of the Indigirka to cross the chains of the left bank; this part of the new range is desert and uninhabited. The journey to the Chibagalakh was very difficult: deep fords, gorges, and high mountains exhausted the horses; we had to abandon nine of them and to leave collections and part of our provisions behind. By the beginning of September we reached the Chibagalakh, having travelled 1600 km. instead of 800 km., as had been previously planned, and having spent two and a half months instead of one month. In Tubelakh we fortunately found flour and butter sent to us from the upper course of Indigirka; otherwise the expedition would have been in a hopeless condition, for we had been able to carry with us provisions for one and a half months only. The Chibagalakh river, a large left-bank tributary of the Indigirka, is at the Polar Circle, between the northern chains of the new range. In all we had crossed from the mouth of the Elgi nine latitudinal alpine chains. The maximum altitude observed was 3300 m.; snow tongues were seen at an altitude of 1600 m. The upper limit of forest was 1300 m. Through the arid climate, there are no great glaciers. According to the guides' tales, there are small glaciers in the two most elevated chains, but we had no opportunity to see them.

Our work having been accomplished at the Polar Circle, the exploring party returned. Winter was approaching, and it was necessary to rescue the caravan by withdrawing it from the alpine chains and going to the south, where some help could be found; for the expedition did not propose to work in winter on the "Pole of Cold," and was not equipped for it. On the very first day of our return journey, September 16, it began to snow, the temperature fell to −10° C. Six times we got away from snow that was overtaking us from the north, but at last the horses, worn out by four months' travel through the mountains, broke down altogether. Reaching the Indigirka at its confluence with the Elgi, we were therefore forced to halt. A small hut was built in which the majority of the men settled, and all the loads were left there. In the middle of

October, after the Indigirka was frozen over (frosts attained −30° C.), I drove the rest of the horses to Oimekon, on the upper course of the Indigirka. This was a tortuous way: the horses were so wearied that in some cases men had to carry them over the ice to save them from starvation. Oimekon is the centre of civilization for the region, with a school, church, hospital, the executive committee, and some Yurts (houses) belonging to the Yakuts. In the region around the upper course of the Indigirka, an area of 250,000 square km., there are only 2500 Yakuts living near the river, and 350 Tungus wandering with their deer in the mountains. There are thus 100 sq. km. per head of population, in the mountains possibly even 1000 sq. km. The Tungus are engaged in hunting, while the Yakuts, in addition, keep cows and horses, engage in trading with the Tungus, and transport goods for the State factories. The Yakuts, a nation of the Mongolian race, came into the region from the south several centuries ago; at the present time they dominate the region, and the Tungus, the remnants of the original inhabitants, are entirely dependent upon them.

In Oimekon we managed to exchange our horses for supplies, warm clothes, and deer for the return journey. We succeeded in crossing once more the Verkhoyansk range on our way to Yakutsk, but this time in sledges. Our work was seriously handicapped by frosts (from −50° to −60° C.) and by the necessity of spending the night in tents at such low temperatures. The range is absolutely unpeopled for 600 km. of the way. "Taryn"* are another hindrance. "Taryn" are a peculiar feature of North Siberia. They are formed in winter when the rivers are frozen through to the bottom, and water which cannot make its way under the ice issues through the gravel of the river-banks to the surface of the ice, where it spreads out in a thin layer and freezes. Considerable areas, many tens of square kilometres, are thus frozen over and the valley covered by an ice layer 3–6 m. thick; this ice does not melt during the summer. In summer "Taryn" present excellent ways for caravans, since they are easier to travel upon than gravel; but in winter the "Taryn" are great obstacles: they are either congealed and consequently very slippery, or else covered with water into which the deer fear to enter. Not infrequently it happens that several layers of a "Taryn" are not wholly frozen up, sledges sink into it, and the deer perish. While we were crossing the range three of our sledges were immersed in this way, one my own and two of our guides; but fortunately all was saved. At a temperature of −60° C. such adventures are far from being amusing. Temperatures of −50° to −60° C., which set in by the end of November, greatly surprised us, for thus far it was supposed that the "Pole of Cold" (with temperatures to −69° C.) was at Verkhoyansk; our observations permit the extension of the cold area as far as Oimekon, and possibly the transference of the pole itself to the latter place; but the solution of this

* It is a Yakut name; in Russian they are called "naled."

question will only be possible after systematic observations during the whole winter.

The most interesting of the discoveries made by the expedition is that of the nine alpine chains on the area of supposed lowland mentioned above. These chains fill the interval between the previously known ranges, Tas-khayakhtakh and Kekh-Tas on the west and Ulakhan-Chistai on the east, and with these ranges form a continuous inner arc in the Verkhoyansk-Kolima region, extending from the Arctic Ocean to the Kolima river, running parallel with the outer arc—the Verkhoyansk, Kolima, and Anadir ranges. The new arc is higher than the outer one, and its altitudes (3300 m.) are the greatest in North Siberia, with the exception of the volcanoes of Kamchatka. The length of the new range is about 1000 km., the width is 300 km., that is to say, it occupies an area greater than the Caucasus. This was probably the last great range remaining to be discovered on the globe. According to the information given by natives the range should continue eastward, between the Kolima and its right-bank tributary the Omolon.

The Geological Survey and Academy of Sciences intend to send special expeditions to Kolima in the near future, and it will then be found whether or not we are justified in extending the inner arc eastward for 500 km. more. The orography of North-East Asia is thus entirely changed: instead of one arc of ranges with radiating ranges within it, we have two huge parallel arcs. The Russian Geographical Society, which retains the privilege of naming new geographical features, recognized the new range within the previously stated bounds and called it the Cherski range in honour of the well-known geologist referred to above.

The arc-like arrangement of the ranges is in perfect accord with their geology. The latter seems to be as follows: the Verkhoyansk range in the parts nearest to the Lena and Aldan consists of intensely disturbed pre-Cambrian formations, the Cambrian and Silurian rocks being thrown into folds that are as a rule parallel to the axis of the range. The margin of the range facing the Lena and Aldan is formed by faults; the valleys of these rivers are lying in the area occupied by the shallow-water Jurassic deposits that contain coal-beds and are squeezed against the range. On the east and north the Palæozoic of the Verkhoyansk range is transgressively overlain by the Triassic; the flat folds of the latter that are parallel to the axis occupy the whole slope of the range facing the Yana and Indigirka rivers; the new Cherski range is made up of the Triassic, but the latter is here intensely folded up, being involved in complicated folds which are likewise parallel to the axis of the range. On the northern slope of the Cherski range the Triassic is again underlain by the Palæozoic (the Devonian, and lower formations) with folds running parallel with the range. So far as it may be judged by such disconnected data, the Palæozoic occupies a vast semicircle within the arc of the Cherski range,

and has on the west folds trending north-west, while on the east the prevailing strike is north-east. We have, consequently, as a whole, two areas of Palæozoic rocks which probably formed a geosyncline ; between them there lies a narrower new geosyncline of the Triassic which has been subsequently subjected to intense disturbances. In the region of the northern Palæozoic there are also some patches of the lower Cretaceous or Jurassic. We should also point out some igneous rocks : diabases in the Palæozoic of the Verkhoyansk range along the fault lines. The Triassic of the range of Cherski has been abundantly intruded with grey granites ; in the Palæozoic of the north there are granites and diabases : the latter as well as the basalts also cut through the Cretaceous. The range of Cherski has been quite recently uplifted as a horst : we have observed on the Indigirka erosion terraces 350, 300, 200, 100, 35, and 10 metres high.

One of the most valuable results of the investigations of 1926 is also the discovery of the traces of a vast post-Tertiary glaciation. Glaciers had descended to 600–700 m. above sea-level both on the Verkhoyansk range and the range of Cherski. On the Aldan slope of the Verkhoyansk range the glaciers were of the alpine type due to narrow valleys and ridges, while on the northern and north-eastern slopes there occurred glaciers of the Scandinavian, or even of the continental type. On the Cherski range near the Indigirka there prevailed the alpine type of glaciation while the Scandinavian type predominated farther away from the river on the area of high plateaux. The zones of glaciations attained 300 km. in width in both the ranges. These zones were in contact with each other in the basin of the Elgi, and it is highly probable that the whole depression of Oimekon was occupied by ice. It has been noticed on the Indigirka that the moraine had been deposited prior to the formation of the 35 and 10 metre terraces. At the present time the region presents a typically post-glacial landscape with trough-like valleys, glacial lakes, and moraines, often up to 400 m. above the valley bottom. Numerous peculiarly shaped hanging valleys running parallel with the main one form a very characteristic feature.

THE WORLD POPULATION CONFERENCE OF 1927

AN important part of the content of Geography is nowadays generally considered to be the study of the Earth as the Home of Man, or, in other words, the study of man's terrestrial environment with reference to its influence on man ; this aspect of Geography has also been described as the science which treats of the relation between the Earth and man, which is much the same thing, only it allows for the action of man on the Earth as well as for the action of the Earth on man. In any definition of Geography this aspect is necessarily given due weight, and we are

accustomed to find at geographical congresses and conferences, sections devoted to human geography, which some people consider the most important branch of the whole subject. But, however this may be, there can be no doubt that the question of population is one which interests and affects geographers, and the calling together of the first World Population Conference is an event of some importance to anthropo-geographers, and indeed to all interested in geography.

The origin of the Conference is to be found in a meeting of American men of science, chiefly biologists, which took place a year or two ago. And in the expression " men of science " we must not forget the " women of science," and those who are especially interested in sociology. In fact, it is an open secret that the inspiration came chiefly from Mrs. Margaret Sanger, and that without her inspiration and generous help no Conference would have been held.

As is often the case, the French description of the meeting is a little more precise than the English. The French version is " Congrès mondial de la Population," that is to say, the Conference was an international meeting called to discuss population questions in general, and was not called specially to deal with the matter of the total population of the world. It would have been better, perhaps, if the English title had been " International Conference on Population Questions," which is what it actually was. The Conference met at Geneva from August 31 to September 3, under the Presidency of Sir Bernard Mallet, who had been Registrar-General for England and Wales from 1909 to 1920. Membership was by invitation. There were strong delegations from Great Britain and the United States, France, and Germany. Altogether, some twenty-five countries were represented.

The main subjects for discussion were, Biology of Population Growth, Optimum Population, Population and Food Supply, Effects of Differential Birth Rate, Fertility in relation to Population, International Migration and its Control, Race Biological Institutes, and Heredity, Disease and Pauperism. Several of the papers had a marked geographical significance. Perhaps one of the most practical, or at least one of considerable actuality, was the paper on International Migration by M. Albert Thomas, the Director of the International Labour Office. Of course, none of these problems is simple ; most, indeed, are terribly difficult. It is probable that the most that can be hoped for at present is the patient accumulation of facts ; then should come the facing of the facts so ascertained. Bit by bit it may be found possible to obtain a general agreement on the treatment of some of the problems. Some may for ever elude solution or treatment. But the human race has every reason to face these problems and to try to solve them.

Take, for instance, the question of migration. As described by M. Thomas, the emigration of Italians into France is " disciplined," that is to say, " the emigrants are formed into groups and subjected to

supervision with a view to the preservation of their national character and civilization." It is impossible for the country receiving such groups to look upon the policy with any enthusiasm. Or take our own problems of migration within the Empire: how many immigrants can a Dominion comfortably receive? And should there be an export of capital alongside of the export of men and women? Without some special provision, can a Dominion absorb more than about one-half of one per cent. of its population in any one year? And does emigration really give any permanent relief? As M. Thomas said, migration problems and population problems are bound up together. Whatever may be the effect in the long run, migration was supposed to afford a temporary relief to an over-populated country. But then comes along Professor East, of Harvard, and tells us that, "if emigration takes place from a country in which there is population pressure to a so-called under-populated country, there is an immediate increase in the birth-rate of the former country which restores the equilibrium."

These are good practical problems which can best be discussed in such a friendly international atmosphere as that of the recent Conference. In the attempt to solve them, full weight must be given to the relevant geographical, historical, and traditional factors. We are not living in a vacuum, or even, most of us, in a laboratory.

At the final meeting of the executive body it was decided to take steps to found a Permanent International Union on Population, and for this purpose an interim committee was elected which will investigate the question of how this can best be done. No definite proposals with regard to the founding of the proposed Union were presented, and it is by no means certain what form it will take. As geographers we may, perhaps, express the hope that the new Union will not entirely be composed of statisticians, biologists, and economists. Such a body would be terribly inhuman; but it could be brought into touch with the living facts of the world of men, if it were to receive some admixture of anthropologists, geographers, historians, and others of wider horizons.

The Congress was admirably organized, both on the technical and on the social side. In such congresses very often the chief result is the bringing together of those working in, or interested in, the same group of subjects. Ample opportunity was afforded during the meeting for valuable informal discussions, which were all the more necessary because the formal discussions were limited by the fact that there simply was not time to give any but the principal speakers an adequate chance of expounding their ideas. All those concerned in the organization of the Conference may be heartily congratulated on the success of this pioneer effort.

C. F. Close.

GEODESY AT PRAHA

THE Third General Assembly of the International Union of Geodesy and Geophysics was held at Praha on the invitation of the Czechoslovak Government, from September 3 to 10; but as usual the Section of Geodesy, having far more work to do than could be done in a week somewhat broken by official hospitality, took time by the forelock and began its meeting on Wednesday August 31 after two days' preliminary conference by its Executive Committee. The extensive buildings of the Parliament House and its annexe gave ample and convenient accommodation for the general assemblies and the meetings of the sections, and everything possible was done by the officers of the Czechoslovak National Committee to make the work of the Congress efficient and agreeable. The best thanks of all the delegates are due to Prof. Nušl, the Chairman of that Committee, to Prof. Šalamon, its Organizing Secretary, and to their staff, for their untiring efforts.

The business of the Section of Geodesy was conducted with its usual efficiency and dispatch under the benevolent autocracy of Doctor William Bowie, its President, and Colonel Georges Perrier, its Secretary. The presentation of the national reports, which increase in number and may occasionally become tedious, was this year conducted with strict self-denial; so that the time allotted to them was not completely occupied, and much more was left for the discussions of the scientific projects that are referred to commissions, and for the consideration of the reports on geodetic topics which are entrusted to reporters. It is impossible in a brief notice to make any attempt to summarize these extensive reports and discussions; but there are several topics which stand out in the recollection of the Conference, demanding brief comment.

The most striking feature in national reports was a paragraph in that of the Geodetic Branch of the Survey of India by Dr. de Graaff Hunter, who has made a new determination of that Figure of the Earth which most closely agrees with the geoid in India, by a method described briefly in his report on Deviation of the Vertical, 1922–24. A corrected solution for the constants of that spheroid, circulated on a slip which missed insertion in the report as originally presented, gave the figures $a = 6{,}378{,}416$ metres, $f = 293{\cdot}3$, as compared with Everest's figures 6,377,304 and 300·8. "This solution involves no hypothesis of compensation, although it is obvious that were there no compensation the geoid would be far more irregular than it is." The report on Deviation of the Vertical, 1924–27, was not ready in time for the meeting. We shall look forward to its appearance with particular interest, because of the announcement made by Dr. de Graaff Hunter in a letter which was summarized at the meeting, that he had rediscussed Hayford's material by this same process, and had obtained the surprising figures $a = 6{,}378{,}213$; $f = 293{\cdot}6$. [But from a letter just received, which will be published in

the December *Journal*, it appears that the result is not so startling as it seemed, since in that solution topography and compensation were ignored. When they are included, his method gives results near Hayford's.]

Next in interest came the account by Dr. Vening Meinesz of his second journey by submarine to the Dutch East Indies; this time *viâ* the Panama Canal and the Pacific Ocean. Recollections of Dr. Meinesz's first voyage will be fresh in the minds of our readers from the excellent account he gave in the *Geographical Journal* for June 1925; and it is the less necessary to go into details of the second since he has promised an account of it at the Afternoon Meeting of the Society in December next. We had at Praha the valuable opportunity of examining his apparatus, and of admiring the skill and resource he had shown in fitting an extensive and complicated piece of machinery into the narrow space available on a submarine, none too large for him and his apparatus. The Section of Geodesy in recording their high appreciation of the importance of this new method of gravity survey expressed their earnest hope that the principal navies of the world would feel themselves bound to follow the example set by the Netherlands Government, and to place from time to time at the disposal of geodesists the facilities of their submarine services.

Very useful, if taken in the right spirit, will be the Report of Commission No. 9, "*Commission de Réglementation Internationale des Travaux géodésiques*." The aim of this Commission is to lay down methods and standards of accuracy to which geodetic work should conform if it is to be accepted as of the first order. Past experience has shown that there is considerable advantage in having an accepted canon, but has always shown the disadvantage of treating this canon as obligatory, and of condemning as heretical work which is not strictly in accordance with the doctrine. We need mention only the unjust aspersions cast on the triangulation of Great Britain through a narrow application of the criterion of Ferrero. Much will no doubt depend upon the translation of the word "réglementation." If the Report of the Commission is taken as a statement of procedure and standards which are sound in general, it will be most useful, especially to those countries newly turning attention to their geodetic problems. But if it is turned into a test of orthodoxy, and those who depart from the canon for good and sufficient reason are to be condemned as heretics, then the "réglementation" may well become a burden. Happily it is general experience that the active people who make improvements in methods and processes are not to be bound by the conclusions of an International Conference.

A project of great importance, and of especial interest to those of us who had the advantage of knowing the late Sir David Gill, was considered by Commissions Nos. 14 and 15, dealing with the possibility of joining the geodetic triangulations of Europe to the Great Arc of Meridian in Africa; and in particular of carrying a new arc of meridian from the

Arctic Ocean to the Mediterranean to be connected with the African arc. For some years there have been spectacular proposals for connecting Crete with the African coast near Sollum by the simultaneous observation of luminous signals fired from a ship at sea. A proposal for an alternative method of photographing luminous signals on the shore from an airship over the sea, put forward by one of the delegates of Greece, seemed to promise evidently more instrumental difficulties, and less chance of realization. The general opinion was in favour of a less sensational but far more useful scheme of encircling the Eastern Mediterranean by a chain of geodetic triangulations through Asia Minor, Syria, Palestine, Egypt, Tripoli, and thence by Italy and the Balkans. This proposal was no doubt inspired by the great success which has attended the work of the Baltic Geodetic Commission.

Some of the best geodetic work in the world is being done by the States bordering on the Baltic, who formed in 1924 a Commission that has not only made good plans for a chain of first-class triangulation encircling that sea, but has already carried a good part of them out. The contribution of Finland, for example, comprises about seventy first-order stations, at each of which astronomical latitude, longitude by wireless, and azimuth are observed, so that every point is a Laplace point, and at each of them gravity pendulums have been or will be swung. That is geodesy of a new order, and an example and challenge to the older geodetic services. Now some of the states implicated have not adhered to the International Research Council, and so cannot yet be members of the Union, while others have and are.

The area covered by the Baltic Geodetic Commission lies athwart the course of Struve's great arc of meridian from Hammerfest to the mouth of the Danube, whose stations are now in great part lost; and equally across any other triangulation planned to reinforce or replace that great enterprise. Yet it was actually held by authoritative members of the Commissions of the Union that because certain of the Baltic states were at the moment outside the Union, it was not permitted to mention in the proceedings of the Union the name of the Baltic Geodetic Commission. The President was happily inspired to talk at some length and with emphatic approval on the forbidden topic; but only this preliminary skirmish was successful. When the Commission on the Arc from the Arctic Ocean to the Mediterranean came to present its report, it appeared that they were nearly equally divided on the merit of the proposition one would have thought self-evident, that any such arc should be attached to the Baltic circuit.

In face of this division the section could not adopt those clauses of the report which had been carried by a narrow majority, still less that on which there was an equality of votes; and the motion made by an impartial observer that the report should nevertheless be printed for information was heavily defeated in a vote taken as if the question were

scientific and not administrative. So the end of the obscurantists was achieved after all, amid dark references by certain states to the " vassals " of another. The episode is worth recording, to show the pitfalls that are yet in the path of international co-operation, and the falsity of the glib assertion that " Science knows no frontiers."

But the Baltic Geodetic Commission are on firm ground, and have no need to worry over this rebuff, for the age of the grand meridian arcs is past. They must inevitably give place to circuits dictated by practical convenience rather than pure geometry, and tied to the spheroid at a multitude of Laplace points instead of by the sparse latitudes that were once deemed sufficient. When these circuits are completed, as round the Baltic and the Eastern Mediterranean, it will be so natural to tie them together by convenient links that the question will be solved by those most immediately interested, without the panoply of approval in advance by an International Union on a large scale. That seems to be the moral to be drawn from the episode of Praha.

There will remain the question of how to combine all the results from time to time into a general solution for the figure of the Earth—a question which seemed so formidable that no one since Clarke in 1880 has felt equal to it. The new Geodetic Tables recently published by the Society as No. IV. of its Technical Series were formally presented to the Section of Geodesy by the Society's delegate with a brief account of their novel feature, that a differential table makes it easily possible to transform from any one figure to another. Though nothing can supersede a final strict numerical solution, it is hoped that these tables will be useful in much preliminary graphical examination of material, and discussion of the kind of contribution that any particular piece of geodetic work can make to the whole problem.

The Commission on the Bibliography of Geodesy resolved to promote publication of an annual volume on the lines of the *Bibliographie Géographique*, and if possible by the same publishers—an arrangement that would have evident advantages in facilitating exchange of material and avoidance of overlapping.

During the course of the meeting the delegates had the opportunity of inspecting two scientific establishments of great interest. The new building of the Military Geographical Institute was described in the *Journal* for January 1927 by Colonel MacLeod. Yet we were not prepared for its size. It would easily contain the Ordnance Survey, the *Service Géographique*, and the Military Institute at Florence within its ample walls, and there was much to admire in the internal equipment. The second was the private observatory of Mr. Frić, destined by its creator to be eventually the National Observatory of the country. Here under the inspiration of Prof. Nušl are installed several instruments of new and very interesting types, including an elaboration of his prismatic astrolabe fitted with an impersonal micrometer.

As usual, after the meeting was over, the delegates were invited to take part in excursions—one westwards to the famous spas and radium mines, and the other east to Moravia and the Tatra. The latter excursion was spent largely underground in all varieties of caverns, including a remarkable glacial cavern near Dobšina, in which hundreds of feet within a mountain there is ice 50 to 60 feet thick, which at least in some places is growing steadily, as is evident from the striation exhibited by sections. It cannot be said that the geophysicists of the party were able to give any explanation of this phenomenon which seemed to meet the case.

The Conference was fortunate in having fine weather in Praha, for the city is all being repaved at the same time, and many buildings are being erected to fit it for its new rôle: happily without damage to the splendour of the old city crowned by the Hrad. The astronomers laid a wreath on the tomb of Tycho Brahe and examined the manuscripts of Kepler. Amateurs of the baroque were delighted everywhere with chapels, palaces, and doorways; and every delegate whatever his tastes must have come home with the grateful remembrance of unbounded hospitality and cordiality in the Czech capital. A. R. H.

TIME SIGNALS FROM THE RUGBY STATION

THE best part of the world reckons its longitudes and bases its time upon the meridian of Greenwich. All the important radio time signals are sent in Greenwich Mean Time, and all over the Empire British surveyors are receiving it; but not from home. When one British engineer invented a clock that far surpasses all others in accuracy, and when other British engineers erected the only station that can reach with certainty every part of the world, it became clear that the establishment of British Time Signals could not, for very shame, be much longer delayed. Some months ago we learned that the Treasury had sanctioned the scheme long pressed upon the Post Office by the Admiralty: and we have now received from the Hydrographer and from the Astronomer Royal copies of the preliminary *Admiralty Notice to Mariners* announcing that during the month of December a service of wireless time signals will be inaugurated at the Rugby W/T Station. Standard rhythmic signals of the new type * adopted by the *Bureau International de l'Heure* in 1925 will be broadcast from Rugby for the two periods of four or five minutes ending at 10^h and 18^h G.M.T.

In a covering letter the Astronomer Royal has kindly explained the

* This type was first proposed in a Memorandum presented on behalf of the R.G.S. to the Time Commission of the International Union of Astronomy and Astrophysics meeting at Cambridge in July 1925 (see *Geog. Jour.*, **66**, 244, Sept. 1925).

reasons governing the choice of 18^h rather than 22^h. The earlier hour will be more convenient for surveyors in Africa, and the signal will be received in India before local midnight, while it will reach the whole of the American continent in daytime. It will also, of course, be very convenient for the whole of Europe. The morning signal will reach Australia between 7^h and 10^h local time.

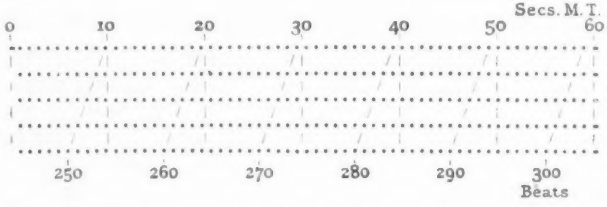
The official account of the system is as follows :

" The time signal will be of the modified rhythmic type recommended by the International Time Commission of 1925, a description of which is given in the Admiralty List of Wireless Signals. It will comprise a series of 306 signals emitted in 300 seconds of Mean Time (or, alternatively, 245 signals emitted in 240 seconds of Mean Time), the concluding signal being the exact hour.

" In each series, signals Nos. 1, 62, 123, 184 and 245 (and 306, if the series extends for five minutes) are single dashes (—) of 0·4 sec. duration and commence at the exact minute. Each dash is followed by 60 dots (•) of 0·1 sec. duration.

" The commencement of successive signals, whether dot or dash, are equally spaced at intervals of 60/61 parts of one second of Mean Time."

It is easier to represent this pattern diagrammatically than to describe it precisely in words :



Three hundred seconds is the interval between the commencement of the 1st and the 306th signal, and there are certain advantages in numbering the signals from 0 to 305 (as in the diagram) rather than from 1 to 306 (as in the official text). The G.M.T. of the signal numbered n in the series 0 to 305 of the morning set is then

$$9^h\ 55^m\ 0^s + 60n/61 \text{ secs.}$$

As soon as we receive the complete and final pattern of the new signal, with its preliminary calls and ending, if any, we shall be able to prepare the new edition of " Wireless Time Signals for the Use of Surveyors " (R.G.S. Technical Series No. 3), which was withdrawn from sale early this year owing to the many changes made since its second printing in January 1926.

The wave length of the Rugby station is given now as 18,740 metres (some 500 metres longer than when the station was opened) ; while Bordeaux is listed at 18,900, though the wave-length signalled each day

in its " URSI " message was recently 19,100. In either case the two signals will be received at practically the same settings of field sets, for ever since the Rugby station began sending it has jammed the Bordeaux time signals with its *CQ CQ CQ de GBR GBR GBR* interspersed with long tuning notes. Since nothing can be better than a rhythmic time signal for tuning, one may perhaps hope that some day all the regular transmissions of Rugby at fixed hours will be preceded by the time signal.

The Short clocks have performed so admirably since they were established at the Royal Observatory that they might almost be " on tap " at any hour of day or night without hourly supervision by the observatory staff: or so one is apt to think. The two signals a day will be of the utmost value to surveyors all over the world: but they will not quite meet the full needs of gravity survey. We may believe that an hourly service of time signals from Greenwich and Rugby will be the future aim of an Astronomer Royal.

CARTOGRAPHICAL RECORDS OF DRAKE'S VOYAGE

Sir Francis Drake's Voyage round the World, 1577–1580.— Two Contemporary Maps. Printed by order of the Trustees; sold at the British Museum, etc. London. 1927. $13\frac{3}{4} \times 9\frac{3}{4}$, pp. 11. *Facsimiles*. 3*s*. 6*d*.

THE wise policy of the British Museum in starting the publication of facsimiles of rare early maps in its possession, at a price which should bring them within the reach of all, has been fully justified by the speedy exhaustion of the first edition of the first of the series—the Contarini map of 1506, published in facsimile in 1924 (see *Journal*, 64, p. 261). A revised second edition, with new introduction by Mr. F. P. Sprent, was brought out last year with praiseworthy promptitude. It has now been followed by a second venture of almost equal interest, in the reproduction of the two maps which probably form the most nearly contemporary record of Drake's great voyage round the world in 1577–80. Their publication marks the 350th anniversary of the departure of the expedition from Plymouth.

Of the two documents reproduced, one is the well-known map of Hondius showing the routes of both Drake and Cavendish; the other, the much rougher production, bearing a title in French and claiming to have been " veuee et corige par le dict siegneur drach," to which attention was called by Mrs. Nuttall in her 'New Light on Drake,' published by the Hakluyt Society. On this Drake's route only is shown. Neither is dated, but the French map is thought by Mr. Sprent to be the earlier, and is dealt with first. It was quite lately discussed by Mr. H. R. Wagner in his portly work on Drake reviewed in the May number of the *Journal*, p. 483. While Mrs. Nuttall set a high value on the map as a supposed indication of far-sighted imperialistic aims on Drake's part, Mr. Wagner thought it unimportant, and probably printed sixty years after the voyage to illustrate a French book of 1641, in which most of the known copies have been found. Mr. Sprent shows certain reasons for thinking the map to have been made, perhaps at Antwerp, soon after the

completion of the voyage, of which it would thus be the first printed record. The general style and contents of the map, the paper on which the Museum copy is printed, the fact that this copy has never been folded in a book, the absence of Cavendish's route of 1586–8, and the disagreement with the book of 1641 as regards the date of the return, are all points in favour of a comparatively early date. (Even were most of the known copies printed for insertion in the 1641 book there is abundant precedent for such late use of an old plate—witness the many re-issues of John Smith's map of Virginia.) But whether the suggested date of 1581 may not be somewhat *too* early seems open to question. Mr. Sprent thinks that the mistakes to be noticed in the French map may perhaps indicate that it was rushed out in a hurry while the interest in the voyage was fresh. Some might draw the opposite conclusion, in view of the many instances of mistakes *introduced* into later versions of maps by careless copying. Mr. Sprent draws attention to instances of unintelligent copying in the present specimen, and it is at least conceivable that the whole map may be the *rechauffé* of an unknown earlier document.

Besides the specimen now reproduced there is a still rarer Dutch version of the map, with so many identical features as to leave no doubt of the close relationship of the two; and as even the French version shows traces of Dutch or Flemish influence it can hardly be questioned that the map did originate in the Netherlands. Mr. Wagner thought the Dutch version the earlier, though if this were conceded, the date of the French copy would be of but secondary interest. We agree with Mr. Sprent in thinking the French map the older, and the following may be suggested as a further argument on this side. Drake's route is shown on the French map by a single dotted line, and to bring this out more clearly a narrow band on either side is left clear of the stippling by which the sea is indicated. The stippling ends, as is natural, with a fairly sharp border, which at first sight might be taken for a parallel dotted line on either side of the central one. The engraver of the Dutch version has, in fact, regarded it as such, and has shown the route by three parallel lines of equal strength—a form which no one without the other map before him would be in the least likely to adopt.

Another argument in the same direction is the far closer agreement with known portraits of Drake shown by that in the French version, the Dutch having more the appearance of a copy at second, or even third, hand. The sources of the early engraved portraits of Drake have never been fully elucidated. Of five that are reproduced either by Mrs. Nuttall or Mr. Wagner, four bear the inscription "[anno] ætatis suæ 43," the date of the fifth, 1598, being probably that of engraving. As the small medallion on the French map is inscribed "atat. sue 42" (which points to 1581 or thereabout), Mr. Sprent thinks this an indication that it was engraved before the others came into circulation. But the tunic worn by the navigator in it closely resembles that in one of those with the age given as 43, and one might think the 2 to be a mere mistake of the engraver—unless indeed the correcting hand of Drake himself may here be traceable. Moreover, we do not know the precise dates of the other engravings, which may have been issued several years after the *painting* of the portrait at age 43.

The date of the French map must thus remain largely a matter of conjecture, and it seems at least possible that the larger map by Hondius may after all be the earlier. Mr. Sprent suggests 1590 as its approximate date, chiefly because he supposes it to have been made in England before Hondius migrated to Amsterdam in about 1593. As Hondius was at work on the Molyneux globe

in or before 1592, and the results of Drake's voyage naturally found a place there, the supposition is not unreasonable, even though the paper used points to Amsterdam as the place of actual printing. The insets showing incidents of the voyage would also imply information obtained in or from England. It is to be noted that the two principal are so closely matched in the French map that some connection between the two pairs is obvious, the resemblance extending even to the firing of a gun from the stern of the *Golden Hind*, shown in one of the pictures. Unless the drawings were taken from an unknown common source, the conclusion could hardly be avoided that the maker of one map copied from the other, though which were pattern and which copy it would be hard to decide.

In spite of its greater intrinsic importance, the Hondius map need not be further dwelt upon, as it has long been known to students. They will be grateful however for a far better reproduction of it than any yet available, the full size of the original having been virtually retained.* We hope that the Museum will continue its good work by reproducing more of its cartographical treasures in the same excellent style. E. H.

REVIEWS

EUROPE

The Place-Names of Worcestershire.— **A. Mawer** and **F. M. Stenton,** in collaboration with **F. T. S. Houghton.** English Place-Name Society, vol. 4. Cambridge: University Press. 1927. 9 × 5½, pp. xliv. + 420. 20*s. net.*

THE collaboration of the three above-named authors, the assistance of many other scholars, and a monetary grant from the British Academy for research in unpublished documents have produced the Worcestershire volume in this excellent series. Over 1500 names are discussed, grouped, as in the previous volumes, under Domesday Hundreds (four of which in the present case are now lost, and two are post-Conquest). Worcestershire presents problems of special difficulty because the English settlement came late, viz. at the end of the sixth century, and the surviving British population probably transmitted some names (*e.g.* Bredon) which were at the time of great antiquity and not understood by the conquerors. Personal names compounded in the place-names of this county are of special interest as contributing notably to the list of English personal names with suffixes -t, -n, and -r, especially the two latter, as in Dudra, Ceadder, Peden. Place-names throw light on Worcestershire history chiefly of an early date: the later Scandinavian element has left few traces. "The local nomenclature of Worcestershire is that of a region in comparative isolation." For this volume the editors have been able to draw upon exceptional materials. Old English documents are very numerous, *e.g.* the late eleventh-century Cartulary of the Cathedral, written by the monk Heming; and the Worcestershire Subsidy Rolls of 1275 and 1327 are exceptional records. Mr. Houghton contributes something fresh, writing on Saltways (pp. 4–9): beside the two commonly recognized Upper and Lower Saltways, he traces out more than a dozen routes. With place-names "things are not always what they seem." Thus in Churchill (pp. 106–9) there is no church; but what lurks behind is OE. *cryc* and Old British *cruc*, meaning a hill or barrow, and the second "hill" is redundant. Forty Hill has no con-

* Actually the length is reduced by about ⅛ inch, as compared with the R.G.S. copy.

nection with the number of the thieves, but is forth-eye, *i.e.* an island or peninsula standing out in low-lying ground. What ordinary man would suppose that Pershore means an osier bank, or Rochford the ford of the hunting dog? In Worcester Fish St. has no fish, but is simply curtailed Corviser-stret, the street of the cordwainers: Cripplegate (as in London) sees no cripples, but is the crypel-geat, the low opening in a fence to allow sheep to pass; and Turkey suggests not Christmas fare, but the street of the tiebridge, a bridge built in a particular style. Spadesbourne Brook has no connection with digging, but is simply Padda's Burn. There is no end to the romance of place-name study. S. E. W.

Roman Britain.— Gordon Home. London: Ernest Benn, Ltd. 1927. (Benn's Sixpenny Library, No. 4.) $6\frac{1}{2} \times 4\frac{1}{4}$, pp. 80. *Map.* 6*d.*

It is a sign of the times when Roman Britain is dealt with in a sixpenny manual in a series comprising such titles as English Literature, Chemistry, Modern Scientific Ideas, and the Development of Political Ideas. Major Gordon Home's eight little chapters are admirable in scope, accuracy, and style, and the printing quite satisfactory. A pity that the map could not have been made double the size to fold in. On the whole this sixpennyworth compares very favourably with the Oxford half-crown'sworth.

In Roman Scotland.— Jessie Mothersole; with illustrations in black and white by the author. London: John Lane. 1927. $7\frac{1}{2} \times 5$, pp. xiv. + 282. *Maps and Illustrations.* 10*s.* 6*d.*

In former books Miss Mothersole has dealt popularly and pleasantly with Hadrian's Wall, and Agricola's Road as far as Newstead (*Trimontium*). She now conducts us rapidly over Roman Scotland from Netherby (*Castra Exploratorum*) on the Esk to Inchtuthill on the Tay. Roman Scotland, of course, means the remains of forts and temporary camps, not villas and farmsteads, as in the south. Since 1900 the spade has done much with Antonine Wall forts and with Newstead, Camelon, Ardoch, and Inchtuthill, the upshot of the excavations being that Agricola's work endured for some thirty or forty years from 81 A.D. The Antonine period of Roman activity extends roughly from 142 to 181; and thereafter we have only the invasion of Severus (209–10). These three periods exhibit a diminuendo of importance. To the Agricolan period belong the original forts along the continuation of Dere Street up to Perthshire, and those along the line Forth to Clyde; to the Antonine period belong the building of the Wall from Forth to Clyde, and the reconstruction of Agricola's forts and the addition of several. Cramond, as yet unexcavated, will probably be found to be the chief contribution of the Severan campaign. The author of these interesting chapters has naturally drawn freely upon the records of the Society of Antiquaries of Scotland, and especially upon the writings of Sir George Macdonald. She warns the intending pilgrim that, as distances are great, a motor car is desirable; also that early summer is the time for such a pilgrimage, and that the Wall is best negotiated "when the bracken is not breast-high upon the mounds." The book is amply illustrated with plates, plans, and sketches; and the ever-increasing public which takes an interest in the Roman occupation of Britain will be grateful to the author for her clear, though brief, "survey of all the permanent forts that are known to have existed in Scotland." The result of her painstaking work is a clear and well-proportioned presentation of the facts, and much useful help in the way of hints how to cover the ground. A separate sketch-map of the forts along the Antonine Wall would have been useful, and should be supplied in a second edition. S. E. W.

The Misty Isle of Skye.— J. A. MacCulloch. Third edition. Stirling: Eneas Mackay. 1927. 7¼ × 5, pp. xvi. + 320. *Sketch-map and Illustrations.* 7*s.* 6*d. net.*

Canon MacCulloch's capital book on Skye is becoming a classic, and has now reached its third edition. A preface sketches the changes in Skye since 1910, the chief of these being due to the Great War. The island played its part nobly: about a fifth of its population joined army or navy. As the result of the Government scheme for settling ex-service men on the land nearly three hundred new small holdings have been taken up, but success with these is by no means assured: the great need is a better transport service. There has been some improvement in the roads, and an increase in the number of visitors to the island.

The Mediæval Castle in Scotland.— W. Mackay Mackenzie. London: Methuen. 1927. 9 × 5½, pp. xii. + 250. *Plans and Illustrations.* 15*s. net.*

Well printed and illustrated, this volume is based on a series of Rhind lectures in archæology, and is an attractive treatment of the subject. The castles of Scotland are of course dealt with in their relation to castle-building generally in Western Europe and to the life of the country. The chief novelty (chap. v.) is in connection with "the palatial castles," that is, the fifteenth-century departure by which the towers became "imposing and adequate residences." The author has views on the use of the word "keep." Thoroughly useful are two chapters (ii. and iv.) on the parts of the castle, *e.g.* donjon, bartizan, allure, barmkin, etc., the meaning of which terms is reasonably defined.

Rambles in High Savoy.— Francis Gos. With a preface by **Geoffrey Winthrop Young** and an introduction by **F. Regant.** Translated by **Frank Kemp.** London: Longmans. 1927. 9¼ × 6¾, pp. 170. *Map and Illustrations.* 21*s. net.*

This is a charming book, not only for the climber but also for the less ambitious tourist. The name of the author is familiar to those who know the Western Alps, for he belongs to a family which has long been identified with mountain scenery and adventure. He has given us some excellent descriptive writing and several accounts of exciting climbs and scrambles, as well as a glimpse of George Sand dressed as a man, wearing a cap with a large peak, a long belted smock, and grasping an enormous alpenstock, looking like some urchin escaped from Töpffer's band of pupils. The photographs, which are reproduced on nearly every page are delightful, and an excellent map has been added. The book could never have been written by an Englishman, but M. Gos is fortunate in his translator, who has not attempted to anglicize his author's style or to restrain his enthusiasm. As a result the book is both fresh and amusing in its form as well as in its matter. M. Gos' narrative abounds in memories of a happy youth spent among the mountains, and one feels that he will never grow old. M. L.

The Land of the Rhone: Lyons and Provence.— H. Quigley. London: Methuen. 1927. 9 × 5¾, pp. xii. + 276. *Maps and Illustrations.* 12*s.* 6*d.*

This is one of a series of publications entitled by the publishers "Books for Travellers." The traveller will, however, find in this number of the series only a very limited description of the country through which the Rhone flows from Lyons to the sea. Even of the towns mentioned the reader unacquainted

with the region will gather but a vague idea, with the exception of Lyons, of which a map is given. The book is essentially a historical sketch of Provence from the early Greek settlements and Roman occupation, with special reference to its literature, architecture, and art. It is, the author says in his introductory remarks, as an illustration of a continuity of tradition and of art that Provence and the Rhone Valley south of Lyons should be judged. The periodical turmoils of the country, and the sufferings of the inhabitants in mediæval times through the ambitions and hostilities of emperors, popes, kings, and barons, and the horrors of the plague, are related. Perhaps the most interesting feature of the work is the account of the city of Lyons with its Renaissance painting and poets, its architecture and religious struggles, and as a seat of art and literature in modern times. There is a chapter on the poetry of the Troubadours, and another on the modern revival of Provençal poetry, in which the works of Mistral are especially dwelt on. The fact that Cézanne and Van Gogh did so much of their work at Arles, and found inspiration in Provençal scenes, gives the author the opportunity for an interesting and critical chapter on Impressionism and the Impressionists, and he concludes his account of this land of glorious sunshine with a panegyric on the wonderful command and use of colour and light shown by these artists. E. A. P.

Fifty Miles Round Paris.— Cecilia Hill. London: Methuen & Co., Ltd. 1927. 7 × 4½, pp. xii. + 188. *Thirty-Four Illustrations and Two Maps (inside cover).* 6*s. net.*

For those visitors to Paris who wish to devote an occasional day to historical and picturesque sites outside but within easy reach of the capital this should be an admirable handbook. The objects for excursion are grouped under the heads of Ghostly Castles, Palaces, Fighting Towns, Cathedrals, Homes of Art, etc., while Fontainebleau and Versailles have chapters to themselves. The authoress has the gift of seeing more than meets the eye and writes with enthusiasm—sometimes, perhaps, with an excess of it, as when declaring that no cathedral has a more majestic position than Chartres; surely it is the mountainous fabric itself that is superlatively majestic, and not so much the position (compared, for instance, with a place on her map but outside her radius—Laon). The photographs are excellent and do not seriously suffer from being, in some cases, rather small. J. H. R.

Brittany and the Loire.— Captain Leslie Richardson. London: Geoffrey Bles. 1927. 8¾ × 5¾, pp. 288. *Eighteen Illustrations and Map (as end-paper).* 16*s. net.*

Yet another book about travel in France! The portions of this somewhat rambling work that deal with the inland navigation of Brittany from Nantes to Pontivy and thence (the canal to Brest being temporarily blocked) down the Blavet to Lorient have some claim to novelty and make the most interesting reading, though many are likely to be deterred from following in the author's wake by the enormous number of locks on this route—about one a mile. The 36-foot auxiliary ketch was supplemented by a motor car, by which the author reached most of the well-known points on the coast between Mont St. Michel and the mouth of the Loire. To descriptions of these are added some reminiscences of former expeditions in this region, and there is a long digression on the sardine and tunny fisheries.

We cannot conceive why the Loire has been dragged into the title and scope of this volume. The reader who is led by the publisher's note to expect a descrip-

tion of the navigation of the river will be entirely disappointed. Less than 10 per cent. of the letterpress deals with anything east of Nantes, and that is occupied by a summary and wholly unnecessary account of the car journey from Menton and back.

The photographs are fair; but, again, why Amboise, Chenonceaux, and Chinon? These places are hardly mentioned in this book and have been illustrated in others over and over again. A more detailed map of Brittany would have been an advantage; and an index is wanting. J. H. R.

Entre Senne et Dendre.— L. Verhulst. (Acad. Roy. de Belgique. Memoires, T. 23, F. 1, No. 1358.) Brussels: 1926. 10 × 6½, pp. 362. 30 *fr.*

The crossing of the Dendre at Alost marks the eastern border of Flanders with its flat plains, while beyond the parallel Senne, on which stands Brussels farther east, the land rises immediately above the 100-metre contour, and continues to rise to the plateau of the Ardennes. M. Verhulst gives a pleasant account of the people and their life in the region of West Brabant between the two rivers, with its western agricultural hop-growing section, and its market-gardening along the approaches to Brussels. The book will furnish a record of conditions during the nineteenth century that will interest students of generations to come, and the author has wisely had this point in mind in compiling his work.

Houses, People, Food, Clothing, Religion, Customs, Education, Philanthropy, Hygiene, Land Tenure, Labour, Family Budgets, Agricultural Methods and Associations, are all treated successively, and then follows a long discussion of the problems of land tenure and the possibilities of its amelioration. The last section gives an exhaustive questionnaire and a series of answers from certain communes. A number of *addenda*, mainly statistical, complete a book which combines an attractive style with a considerable amount of valuable matter for reference. It is evidently a product of native knowledge, and pictures very fairly the hard-working, if not perhaps very attractive, peasantry that so many English traveller sknow. H. J. F.

Constantinople. Settings and Traits.— H. G. Dwight. London: Harper Brothers. 1927. 9 × 6, pp. xxiv. + 582. *Maps and Illustrations.* 16*s. net.*

This book is an American descriptive work intended for the returned traveller and the general reader. The author knows his subject well and has much to say about Constantinople and the Turks which was worth saying, but he has not caught the fascination of the city nor given it an adequate historical setting. It seems that the book was first published in 1915 under the title of 'Constantinople Old and New.' Since he has occupied himself with the work of revision the author might have cut the volume down by one-half without sacrificing much that is of value, and he should certainly have supplied a fresh index, which is as bad as any index could possibly be. It seems a pity, too, to compile a work of this kind without devoting some space at least to the early travellers who have much to say which is of interest to the visitor and student of to-day. Busbecq, for instance, is not apparently referred to in the text. The author mentions M. Ebersolt in his bibliography, but has overlooked his 'Constantinople Byzantine et les Voyageurs du Levant,' which is a mine of information on the visits of travellers from the ninth to the nineteenth century. A special word must be said for the illustrations, which are excellent.

M. L.

Firenze nelle Vedute e Piante.— Studio storico, topografico, cartografico di **Attilio Mori** e **Giuseppe Boffito.** Firenze: L. Franceschini. 1926. 10 × 7, pp. xxx. + 174. *Maps, Plans, and Illustrations.* *L.*100.

The editors of this attractive collection of views and plans of Florence have supplied a real need, for the searcher after topographical material for Florence of the past has hitherto had a very wearying task. He has now an index to the whole subject, which in its way will be as valuable as the researches of De Rossi, Rocchi, Ehrle, and Huelsen on Rome, and of other workers who have dealt with several Italian cities. Particularly valuable are the references to and reproductions from manuscripts. The codex Laurenziano-Tempiano, although largely concerned with foodstuffs and prices between 1320 and 1335, contains some interesting pictures of Florence at that time. In one the artist intending to represent the driving out of the poor from Siena during the famine of 1328–30, has in fact depicted Florence within its first circle of walls, and shows us the Porta del Vescovado, Santa Reparata, the Badia, and Giotto's Campanile not yet completed. In another we see the walls, the Baptistery, the tower of the Bargello, and other buildings, while outside the walls the pious citizens are bringing food to the starving poor. Another delightful picture comes from a Paris "Boccaccio" of the fourteenth century, with glimpses of the Palazzo Vecchio, the Baptistery, the Campanile, and the façade of Santa Reparata, the tower of which was destroyed in 1357. The pilgrim book of Marco di Bartolommeo Rustici, who went to the Holy Land in 1425, supplies a spirited drawing of Vecchio San Lorenzo with a flag flying bravely from the tower. Other manuscript illustrations are noted, with references to the various works where reproductions may be found, so that the student should have little difficulty in finding illustrative matter for any period on which he may be working. When we come to the sixteenth and seventeenth centuries we reach an age of folding plans and panoramas. These are catalogued and in many instances reproduced, and help us to recapture something of the excited wonder with which the early tourists regarded Florence: "a city only to be seene upon Holydayes, being too fine a sight for working dayes." * M. L.

The Story of Naples.— **Cecil Headlam** and **Major Benton Fletcher.** London: J. M. Dent & Sons, Ltd. 1927. 6¾ × 4¾, pp. xiv. + 396. *Map and Illustrations.* *5s. 6d. net.*

For the Mediæval Town Series Mr. Headlam has written a useful guide-book to Naples, which includes Pompeii and the classic region of the Phlegrean Fields. He has wisely devoted his first chapter to modern Naples, but it is a pity that his enthusiasm for the ancient city overshadows the later history. It was under the Spaniards and the Bourbons, in the seventeenth and eighteenth centuries, that Naples contributed most to the culture of the peninsula in the Commedia dell' Arte, in literature and music, of which latter he says nothing, while Baroque art found its natural home there; and surely the museums deserve more than thirteen pages out of some four hundred. The book gives a good idea of the city as a whole, and is well produced. The plan is admirably clear.

Geologie von Europa.— **Serge von Bubnoff.** (Geologie der Erde.) Berlin: Gebr. Borntraeger. 1926. 10½ × 7, pp. viii. + 322. 8 *Plates.* *M.*22.50.

Knowledge of scientific progress in Eastern Europe has lagged seriously since the War. The references in this volume show how much new literature is appearing in Russian of which Western workers have but little knowledge.

* The more important engraved plans were discussed (with reproductions) in *L'Universo*, Anno V. No. 8, 1924 (see *Journal*, **65**, p. 272).—Ed. *G.J.*

Hence Professor Krenkel is to be congratulated on having entrusted the preparation of his 'Geology of Europe' to Professor von Bubnoff, who from his position at Breslau is necessarily concerned with the structure of Eastern Europe. His volume begins with a summary of the distribution through Europe of the successive geological formations, illustrated by a series of seventeen sketch-maps of the ancient geography of Europe which will alone secure for this volume careful attention. It discusses the problem of European gravity anomalies, and contrasts both the crustal deficiency of the Alpine regions and the Spanish Meseta and the excess under the Mediterranean with the more complex conditions of the European Plain which is composed of areas alternately above and below normal. This character holds, though less markedly, in Russia. The chapter on the morphology of Europe points out that the primitive features of its structure are repeated in the present relief. The main and most valuable part of the work consists in the account of Eastern Europe, where the present surface features are less directly dependent on the geological structure than in the west, as large areas have been planed down by long-continued denudation.

The essential structural element in Eastern Europe is the great Russian Tableland which extends westward beyond the Vistula. Professor von Bubnoff divides it into fifteen main divisions. The basis of the tableland is a sheet of ancient rocks which forms the surface in Finland and Lapland, while two blocks, that of Voronezh and the Podolian block between the Dnieper and the Dniester, are the best-known remnants of the Russian Platform. The continuity of this sheet has been destroyed by subsidence, whereby most of it in Western Russia and the adjacent states has been buried beneath later deposits; these areas include the East Baltic Tableland, the Tableland of Galicia, the less deeply buried block between the White Sea and the western branch of the northern Urals, and that which underlies the South Russian sunkland which lies between the Voronezh and Podolian blocks. Most of South-Eastern Russia is occupied by a great sunkland which includes the Moscow basin and extends eastward to the Urals, the part east of the Vyatka Range and of the Trans-Volgan Axis forming the East Russian sunkland. Other sunklands form the basin of the Caspian, the Black Sea, and the basin of East Prussia and Poland. The basins are interupted by uplifts of late Palæozoic age, but the mountains thus made have been so worn down that they are traversed by the rivers and have no effect on the primary hydrography. The Ural Mountains and the Caucasus have each an axis raised by older Palæozoic folding; but their effect upon the present surface is due to uplifts, which in the Ural Mountains were Mesozoic and in the Caucasus were also Kainozoic.

The author's account of the structural elements of Europe is naturally less useful as regards North-Western Europe as it is farthest from his own field. Although in the text he describes as doubtful the hypothesis that the Norwegian and Scottish Highlands are largely composed of altered Ordovician rocks, yet he accepts in his map this fundamental misinterpretation of Scottish Geology. The book will be a most useful work of reference on the structure of Eastern Europe. J. W. G.

Landeskunde der Sudeten- und West-Karpatenländer.— Prof. Dr. Fritz Machatschek. (Bibliothek Länderkundlicher Handbücher, herausgegeben von **Prof. Dr. Albrecht Penck.**) Stuttgart: J. Engelhorns Nachf. 1927. 9¼ × 6¼, pp. xii. + 438. *Maps and Illustrations. RM.*30.

Much as we welcome recognition of the "Natural Region" as the unit proper to geographical studies, we must none the less deplore the title that

Dr. Machatschek has here chosen. Of all the countries either newly set up or reconstituted by the post-war settlements, Czechoslovakia—for, with the exception of Carpathian Ruthenia, it is this *political* entity which is the real scope of the book before us—has, we should have thought, the least claim to be regarded as so based upon natural considerations that it can be described even roughly by such a title. The author tells us (p. 5), and without shame we confess our ignorance of the fact, that Bohemia, Moravia, and Silesia have long been known as the "sudetische Ländergruppe," with the added comment "gewiss keine ganz glückliche Bezeichnung, da ja ein gutes Stück Mährens und das Teschner Gebiet schon ganz ausserhalb des sudetischen Gebirgssystem liegen, wenn man schon diesen Ausdruck als pars pro toto . . . gelten lassen will." *Pars pro toto* indeed! This is not to disparage an exceptionally valuable book, but rather to indicate and emphasize for English students its real content and character, and with the hope, if it be not too presumptuous, that Dr. Machatschek may find some more adequate description for future editions. For the actual division into *twelve* natural regions—with further subdivision—we have nothing but praise. We have no space to discuss the subject matter in any detail. The arrangement is clear, the maps and illustrations are plentiful and good. The book is well indexed and has a very thorough bibliography.

To describe the book as a mine of up-to-date information about Czechoslovakia would be true, and yet do a grave injustice, for, though "encyclopædic," its value resides less in this than in the way in which, upon a basis of geomorphological and other physical factors, the various human aspects of what is more properly geography are successively developed. To give an instance, rock-hardness and storm-power are adduced to explain a particular anomaly in the tree-line, while due weight is given to ecology—the interstrife of plant associations—and the reaction of man to nature (p. 87). Nothing, again, could be better than the relation of village and house types to geographical factors (pp. 152 ff.), without such undue exaggeration of the influence of environment as would call for the caustic irony of a Febvre. The historical side, in fact, appears to us to be quite as well treated as the physical, all the relevant factors being brought into harmony in a way which, if maintained in other books of Penck's series, should make a noteworthy contribution towards broad syntheses built up inductively from these local studies, and do much to counteract the tendency towards hasty generalization and accommodation of facts to insecure theory, with which one type of geographer has made us too well acquainted. A. J. P.

Die Urbevölkerung Griechenlands. I.— **J. R. Mucke.** Leipzig: Oswald Weigel. 1927. Pp. iv. + 328. *Portrait.* 12*s.*

The late Professor of "Geography, Ethnography, and Statistic" at Dorpat regarded the monograph, of which this is the first instalment, as his *chef d'œuvre*. Whether his friends were well advised in allowing it to be published as it stands readers will judge for themselves; and the anonymous editor admits that Mucke's views on prehistoric questions were peculiar, and are not yet generally accepted. The notion, elaborated in the first chapter, that in primitive times, as in many uncivilized regions, "hordes" or small communities of different language and culture lived intermingled, and interpenetrated large regions, occasionally coalescing into "peoples," is a valuable corrective to popular theories about "migrations" and "diffusions." A second notion, that the modes of life represented in such regions of interpenetration may be classified as essentially either "highland" or "marsh-

land" cultures—somewhat precariously identified respectively with pastoral and agricultural *régimes*—seems to simplify matters unduly; and the subdivision of "highland" life into peak-haunting pastorals and cave-haunting industrials is fantastic. The chapter illustrating primitive Greek conditions from simple forms of society in other parts of the world contains some striking analogies, but displays curious aloofness from the constructive ethnology of the last thirty years. But it is only in the third chapter that the author gets into his stride. Here the marshland folk are our dear old friends, the Pelasgians; the mountaineers are the Hellenes. They are respectively constructors of "pile dwellings" and "stone platforms"; and ruinous "pile dwellings" were mistaken for "Pillars of Hercules," a geographical novelty. There were also "cave-dwellings," mistaken for "treasuries" by ancient archæologists, and for tombs by modern. And so forth. It is not that Mucke was unacquainted with archæological work, though he hardly mentions it. He seriously disapproved of it, and of the contributions of cuneiform studies to the early history of Greek lands. That "the spade had begun to replace the pen" he regarded as a disaster, likely to render obsolete his own more "scholarly" procedure, which detected, for example, in the name of Midas the same word for a "marsh" as in Midgard, the snake which in biting its own tail "forms a stone circle" (p. 327); and of course (on curious botanical grounds) "the marsh has asses' ears" (p. 328). Frankly, much of this ponderous essay is nonsense, and very little of it geography. J. L. M.

ASIA

Die Palästina-Literatur.— Eine internationale Bibliographie in systematischer Ordnung mit Autoren- und Sachregister, unter Mitwirkung von **J. de Groot, A. Gustavus, Sam. Klein, Chr. O. Thomsen, Will. Zeitlin,** bearbeitet und herausgegeben von **Peter Thomsen.** Band IV. [in two parts.] Die Literatur der Jahre 1915–1924. Leipzig: J. C. Hinrichs'sche Buchhandlung. 1927. 9½ × 6½, pp. 400. Teil I. *M.*20; Teil II. *M.*19.

It had been hoped to issue vol. 4 of this extensive bibliography, covering the Palestine literature for the years 1915–1919, in 1920, but the after-effects of the War and the difficulty of access to foreign publications and periodicals delayed the editors, who have now extended the scope of the volume so as to include the years 1919–1924. It is difficult to test the accuracy of a bibliography such as this except by constant use, but very little can have escaped Prof. Thomsen's net. The War in the East, the development of post-war Palestine and Syria, and the Zionist movement, have produced a mass of literature which has been duly examined and digested, and the work now provides an exhaustive survey of Palestine literature from 1895 to 1924. It is an extraordinary undertaking which deserves the highest praise. Prof. Thomsen proposes to continue his labours if health and strength permit, and he asks that authors and publishers should keep him in touch with their work, and send him, if possible, copies of any books or pamphlets bearing on his subject to Laubestrasse 11, Dresden-A. 19, also that errors and omissions should be notified. It may therefore be useful to mention that Mario Esposito's articles on Symon Semeonis, which were published in this *Journal* in November 1917 and February 1918, have apparently been overlooked. M. L.

Islands of Queen Wilhelmina.— **Violet Clifton** of Lytham. With an introduction by **Lord Dunsany.** London: Constable & Co., Ltd. 1927. 9 × 6, pp. xv. + 288. *Numerous Illustrations and a Map.* 18*s. net.*

This book is the record of two journeys made by Mrs. Clifton and her husband in the Dutch East Indies. The first part describes a visit, in 1911,

to Sumatra, Nias, Java, and the neighbouring islands; the second, undertaken ten years later, deals mainly with Celebes. Mrs. Clifton's descriptions of Sumatra are always graceful and sympathetic, but the second part of her book is far the most important, particularly the chapters which describe the crossing of Celebes from the south to north.

Mr. and Mrs. Clifton reached Paloppo, in the Gulf of Boni, by boat, and were able to motor to Masamba, 45 miles inland. There the road ceased, and the rest of the journey was made by pony and on foot through an upland no man's land which lay between the districts of Masamba in the south and Posso in the north. The palisaded village of Leboni, 54 miles from Masamba, was reached in three days, and while staying there Mr. Clifton shot a fine specimen of the rare *bos anoa*, the smallest of the wild oxen and peculiar to Celebes. From Dololo, a day beyond Masamba, the way was through virgin jungle previously unpenetrated by Europeans as far as Manoewana, whence there was a well-engineered path for 120 miles to the coast. On the way, at Besoa, Mrs. Clifton came upon ten ancient monuments made of grey stone, in the shape of wells, with great covers of stone upon which apes were carved in bold relief. Apparently no one knew their history, and the author believes that no other European had ever visited them.

From Besoa the travellers reached Posso on the northern coast, after a journey of seventeen days, during which they had covered 265 miles. Mrs. Clifton is to be congratulated on being the first woman to have crossed Celebes, and also on having described that journey with such good humour and so much restraint; neither in this part of her book nor elsewhere does she once enlarge on the dangers and discomforts she encountered; obviously she was content to travel philosophically, taking things as they came and accepting the customs she found. The book is unusually well illustrated and has a sketch-map which clearly shows the author's route and gives the reader just the information he requires. Would that all books of travel contained so much!

O. R.

Geologie von Sibirien.— W. A. Obrutschew. (Fortschritte der Geologie und Palæontologie, Heft 15.) Berlin: Gebr. Borntraeger. 1926. 10 × 6½, pp. xii. + 572. 1 *Folding Map and* 10 *Plates in Pocket*, 60 *Figs.*

The vast amount of research which has been carried out on the geology of Siberia is not, perhaps, generally appreciated. Many of the results have been published in Russian and remain unknown to the scientists of Western Europe. Geologists and geographers will therefore be under a debt of gratitude to Dr. Obruchev for having rendered available, in a very convenient form, the main results of work carried out down to 1925. His book is fully documented and includes a bibliography of nearly 400 items, the majority of which are in Russian. After an introductory section in which, following Suess, seven geomorphological units are separated (West Siberian Lowland; Kirgiz Steppe; Angaraland; Verkhoyansk Region; Altai Region; the old Asiatic Shield, and Peripheral Ranges to the east of the Shield) the author follows the method of considering the development of each of the great systems. The final section of the main work deals with eruptive rocks and tectonics. Completed in 1924, the text has been brought down to the latter part of 1925 by the addition of an appendix of fifty pages.

Over much of the area dealt with we have few criteria whereby the accuracy of the author's summary may be judged. Over certain areas, however, a most instructive comparison may be made with the accounts given in Dr. A. W.

Grabau's recently published 'Stratigraphy of China' (*Geol. Surv. China*). In parts there is evidence that some of the matter is ill digested and the author seems rather to misrepresent the views of the authorities he quotes. He does not, for instance, deal with sufficient care with the vexed question of Siberian glaciation, tending rather to confuse glaciation by ice-caps and the work of valley glaciers. These minor points do not, however, detract from the undeniable value of the work as a whole. The very instructive tectonic map is worthy of particular mention. L. D. S.

Bei den Urwaldzwergen von Malaya.— Paul Schebesta. Leipzig: F. A. Brockhaus. 1927. 9 × 6, pp. 278. 150 *Illustrations and a Map.*

The Semang of the Malay Peninsula are among the least known peoples of the world. Living in the remotest and densest parts of the forest they are shy of strangers, and Herr Schebesta is the first European to have lived amongst them and to have made a comprehensive first-hand study of their customs and mode of life. His expedition, which was financed by Pope Pius XI., lasted from January 1924 to September 1925. He was well received by the Semang and travelled with them through the forests, sharing their life, accompanied only by one Malay servant, and taking with him the barest necessaries of life.

The Semang are the oldest inhabitants of the Peninsula. They are nomadic, and their numbers are estimated at about 2000. Civilization is thrusting them into increasingly smaller regions of the forest; there is a scarcity of women, and they are gradually dying out. They have learnt opium-smoking, but fortunately syphilis is still unknown among them. Their own weapon is the bow and poisoned arrow, but to-day this is little used, as they have learned to use the blowpipe of the Sakai. The forest cannot support a large number of them in one place, consequently they are found in small groups without any tribal organization, the father in each family being the only authority; but each group has its hereditary region to which it returns after free wandering. Men and women have equal rights, and polygamy, although permitted, is seldom practised. They believe in a future life, and their deity is the god of Thunder.

Herr Schebesta has produced a work which is a serious and valuable contribution to social anthropology, and he is to be congratulated on having been able to gather much valuable information about these primitive and interesting folk before it was too late. The book is well illustrated and indexed, with a good map showing distribution, and it is to be hoped that it will be translated into English. O. R.

The Revolt of Asia: The End of the White Man's World Dominance.— Upton Close (J. W. Hall). New York: G. P. Putnam's Sons. 1927. 9 × 6, pp. xiii. + 325. 10*s.* 6*d. net.*

The rise of nationalism in the countries of Asia is a subject of vital importance to the world, and one deserving the closest sympathetic study. It is difficult, however, to regard the present volume as a serious contribution to that study. Written in extravagant, journalistic language, the interests of strict accuracy tend to be sacrificed to the fullest possible justification of the sub-title. The author is probably correct in his main thesis, but many of his observations are superficial and his deductions of doubtful validity. Thus rubber-planters' bungalows represent "the British-hope of a 'White Malaya'"; "British business conservatism and inefficiency and demand for huge dividends make petrol in Burma twice the usual cost of 'gas' in the U.S.A." (p. 36); "that great imponderable, British Prestige, of which men once spoke with

awed voices, went out of existence when Hongkong was brought to its knees by striking coolies and boycotting hongs" (p. 181). Nevertheless "as Japan and Great Britain are doing, America too must find her particular line of 'enlightened imperialism' to follow in dealings with Asia" (p. 300).

L. D. S.

AFRICA

France, Spain and the Rif.— Walter B. Harris. London: E. Arnold & Co. 1927. 9 × 5½, pp. xii. + 338. *Maps and Illustrations.* 21*s. net.*

In this book the *Times* correspondent in Tangier gives an impartial and eminently readable account of events in the Jibala and the Rif from the signing of the 1912 treaties down to the end of 1926; a succinct introductory chapter includes a concise statement of the status of the Tangier zone, and is followed by a brief sketch of the origins and previous history of the Berbers of the Rif.

A life-long observer of Moroccan affairs and the friend or acquaintance of most of the protagonists of the period, Mr. Harris writes with authority. The book is illustrated by excellent photographs.

East Africa: A New Dominion.— Major A. G. Church, D.S.O. London: Witherby. 1927. 9 × 5½, pp. 315. *Illustrations and Sketch-map.* 18*s. net.*

Major Church was a member of the Parliamentary Commission which visited East Africa in 1924, and thus had unusual opportunities for observation and investigation. He has also studied the problems of East Africa in various other ways. His conclusions therefore deserve careful consideration.

The geographical factors which to a very large extent must mould, though they may also in degree be made to serve, future development are set forth. and there is insistence on the need of increased transport facilities. For the most part, however, Major Church is concerned with what may be called moral questions, as may be gathered from the sub-title of his book: 'A Crucial Experiment in Tropical Development and its Significance to the British Empire.' His standpoint is that of the Kenya White Paper of 1923, namely, "the interests of the African natives must be paramount." He seems to think that that object can be best attained under the searchlight which the mandatory system affords, and he would like to see that system extended to all the East African territories. He also looks forward to the creation of a single East African Dominion, with its capital in Tanganyika. There is much in praise of the white settlers, and much in criticism of them; the claim of the white settlers in Kenya for self-government means, he says, a claim by 10,000 whites to dispose of the destinies of over 2,000,000 Africans, besides the Indian settlers, and he dismisses the claim as fantastic. His own solution is that in Kenya and in the other territories the whites, the blacks, the Arabs, and the Indians should each have "community self-government. The four communities would raise their own taxes and disburse them . . . contributing their quota to the general expenses of administration of the whole territory." The encouragement of "home rule" among the Africans—under official superintendence—is a well-known feature of British colonial policy, and in Kenya a community franchise for the other races has already been introduced. Whether Major Church's solution is either desirable or practical is a question we need not discuss here.

In one respect Major Church and Lord Delamere—the leader of the whites in Kenya—whose views differ on many points, are agreed. Both believe that the belt of high land extending from Northern Rhodesia to Kenya is a proper

field for white settlement. In the author's view however all land in East Africa should be leasehold "with adequate safeguards to the leaseholder." He praises the experiment now being made in south-east Tanganyika Territory of granting white settlers not freeholds but ninety-nine years' leases. The land question is indeed one which greatly stirs the author, for he believes that "freehold rights in land lead to the worst form of speculation." Here again we are not called upon to follow up his thesis. But we are in cordial agreement with his contention that the chief needs of the natives at the moment are better housing, sanitation, and education. F. R. C.

In Ashanti and Beyond.— A. W. Cardinall. London: Seeley, Service & Co., Ltd. 1927. 9 × 6, pp. 288. *Map and Illustrations.* 21*s. net.*

Mr. Cardinall has produced a pleasantly written book which reflects much of the intimate knowledge of the country dealt with which its author possesses. While it cannot be said to add greatly to our knowledge of the tribes among whom Mr. Cardinall has lived, it does give a good many clear-cut pictures of the results of the mixture of cultures which is taking place so rapidly in West Africa, and the results produced in the brains of men by solitude are also well illustrated. It would be difficult to beat the following successful dramatization of a wish fulfilment: "Another used to have a paper sent out daily from home. These he would arrange in order of date on their arrival in the mail and hand the bundle to a small boy, whose duty it was each morning, after his master had risen, to run up the path shouting: 'Pia-pa! Pia-pa!' The man then shouted out: 'Boy, boy! Bring me a paper.' The boy handed him the top paper—six weeks behind in time—and received for it one penny. That penny was placed by his master's bedside for use next morning. On Sundays a Sabbath paper replaced the daily one."

There is a chapter on big-game hunting which gives a good idea of a native game-drive in thick forest, and the book is illustrated by some good photographs. C. G. S.

La Géographie de l'Égypte à l'Époque Arabe.— S. A. le Prince Omar Toussoun. Tome I. La Basse Égypte, première partie. (Mémoires de la Société Royale de Géographie d'Égypte, tome VIII. 1.) Cairo. 1926. 11 × 9, pp. xvi. + 214 (+ vii. plates). 60 *piastres Egyptian.*

This volume is an apt reminder of the mass of geographical data contained in the works of the mediæval Arabic geographers which still awaits critical study and presentation to the world at large. More than thirty years have passed since de Goeje completed his critical editions of the great ninth and tenth century geographers, but except for one or two scattered areas we have as yet no detailed descriptions of the various provinces of the mediæval Islamic world. For Egypt the materials are more than usually abundant, thanks to the Mamluk Government and its officials, and the present work promises to run to several quarto volumes.

The main object which Prince Omar Toussoun has set himself is apparently to investigate the administrative geography of Egypt between the years 640 and 1517. The lists of provinces and circumscriptions (*kurahs*) given by the various early authorities are compared with one another, and the position of each is fixed. The provincial reorganization of the middle of the eleventh century is then briefly examined, the later reorganizations being left over to the next volume. A series of useful maps is added to illustrate the administrative divisions of the Delta in successive centuries. It is not intended, however, if the system followed in this first volume is maintained, to present a complete

corpus of the information about Egypt that is to be found in the works of the mediæval geographers. Abbasiyya, for example, which is referred to by a tenth-century writer as the capital of the "Rif," is here mentioned only in the list on p. 8, and is not shown on any of the maps, while many other details given by mediæval writers, and even some of the writers themselves, are completely ignored. On the other hand, by far the larger part of the present volume is taken up by a translation of all the entries relating to Lower Egypt contained in the thirteenth-century geographical dictionary of Yaqut.

The principal criticisms to be offered are that the discrepancies of the early writers invite fuller discussion than they receive here, and that the arguments and conclusions reached in regard to certain of the *kurahs* and provinces are somewhat meagrely supported by authorities. In the translations from Yaqut there are a number of unexpected, if minor, errors, and some obscurities are left unexplained; how many readers, for example, are likely to recognize the Turkish Sultan of Anatolia under the guise of "le roi des Grecs"? One would have liked some fuller reference in the text to the Arabic map reproduced in Plate VII. Nothing is given except the date of the manuscript (1184), though the work in which it appears dates from the middle of the tenth century; in either case it does not fully square with some of the conclusions reached by the author. Nevertheless, this work fills a gap, and it is to be hoped that it will soon be brought to a successful conclusion. H. A. R. G.

Afrique Centrale. La Colonie du Niger.— Maurice Abadie. Preface by Maurice Delafosse. Paris: Société d'Editions Géographiques. 1927: Pp. 466. *Map and Illustrations. Frs.* 60.

There is often great difficulty in finding a single book which will give a comprehensive survey of any particular British colony or protectorate. The French seem to have a particular aptitude for producing just what is required, so that the traveller in their overseas possessions need seldom experience the serious handicap to intelligent travel which is all too frequent in British territory. The volumes on Haut-Sénégal-Niger by Meniaud and Delafosse were models of what such works should be.

In 1914 we were promised a companion volume on the remote Territoire Militaire du Niger, which lies to the north of Nigeria and largely within the Sahara. Owing to the war it was never written. Meanwhile the Territoire Militaire was brought under administrative control, and has now been promoted to civil status under the name of La Colonie du Niger. The work of preparing an authoritative volume on the new colony was entrusted to Col. Maurice Abadie. As the result of his labours a great mass of valuable information regarding a little-known country has now become available. In its careful arrangement and attractive presentation the book is fully up to the high standard set by its predecessors.

The book is divided into four parts devoted respectively to *Description Physique*, *Les Populations*, *Les Productions*, and *Organisation et Administration*. There are also twenty-four appendixes containing much detailed supplementary information on a variety of subjects, including tribal history, folklore, roads, and natural history.

Much space is devoted to the physical description, and some of the detail may be considered excessive. This is rather the fault of the varied nature of the country than of the author. Progressive desiccation appears to be causing real concern for the future, as can be readily understood by those who have witnessed the same process across the Nigerian frontier.

The second part is a valuable review of the varied native population. Besides many negroid tribes, the most numerous of whom are Hausas and Zabermas, there are Fulani, Tuareg, and Arabs. A welcome addition is made to our now rapidly growing knowledge of the Tuareg tribes, and the controversy over the origin of the Fulani is disposed of to the satisfaction of the author if not to that of all his readers. With this excusable exception the author is most careful not to intrude his personal views. Few can resist the Fulani controversy.

Col. Abadie deplores the fact that the exploitation of the very restricted economic resources of the country is almost entirely in the hands of natives from British Nigeria. He compares our enterprise in developing communications in that country with that of his own countrymen, much to the disadvantage of the latter. He appears particularly to regret the failure to prolong the Dahomey railway up to the Niger. While admiring his zeal for his own colony we must admit that there seems to be little justification for such a costly extension of the line.

Colonel Abadie shows an excusable lack of familiarity with conditions in Nigeria. Apart from the not uncommon mistake of greatly exaggerating the importance of Sokoto his errors are of small consequence and do not throw any doubt upon his general accuracy. It is to be hoped, however, that his statement that Mungo Park's grave is to be found near Jebba (p. 311) will be corrected in a future edition.

The value of the volume is increased by a good bibliography and index. It is lavishly illustrated with excellent photographs; moreover, the binding, for a French book, is good, and complete disintegration does not take place before the volume is read. We seldom find such a good ten shillings' worth.

E. W. B.

AMERICA

Across Arctic America.— Knud Rasmussen. New York and London: G. P. Putnam's Sons. 1927. $9\frac{1}{2} \times 6\frac{1}{4}$, pp. xx. + 388. 64 *Illustrations and* 4 *Maps.* 21*s.*

The Fifth Thule Expedition, of which this book is the outcome, lasted three and a half years, from 1921 until 1924. Organized and financed from Denmark, its object was to apply the knowledge of Eskimo ethnology and folklore, acquired by the author after twenty years in Greenland, to the kindred tribes of Arctic Canada. A base was established north of Southampton Island, and preliminary journeys made to the Barren Grounds, to Fort Churchill, and north to Igdlulik (once very familiar as Sir Edward Parry's Igloolik). Rasmussen himself first visited the Caribou Eskimo on the Barren Grounds, and then set out on a two years' journey from Southampton Island to Bering Strait along the entire length of the Canadian Arctic coast. The earlier, shorter journeys were largely the province of the subordinate staff, and only brief references are made to them in the present book: during their execution attention was mainly directed to the excavation of old sites (of the "Thule" period), with results of first importance to the problems of Eskimo origin—one of the main objects of the expedition.

The book is definitely not an "official narrative": but it is something much better, and comes very close to being an epic. The central figure and hero is the Eskimo; his character is unfolded partly by straightforward analysis, partly by suggestion in folk tales skilfully told. Rasmussen's great journey is merely a thread throughout the narrative and the means of linking up the incidents and taking one on from tribe to tribe. The resulting picture of

Eskimo life—hunting, domestic and spiritual—comes out very clear and sharp, but differing considerably from the general English notion.

This is in every respect a great book. It need not be the only one on the expedition. The various journeys covered a distance of over 20,000 miles; at the end the leader stood on a headland on Bering Strait, with his original dog team, and could exclaim, "From my heart I bless the fate that allowed me to be born at a time when Arctic exploration by dog sledge was not yet a thing of the past." He had visited Repulse Bay, King William Island, and the mouth of Back's Fish River, all of them historic names, to which the fate of Franklin has given a special atmosphere. There is plenty of room, therefore, for a further account, for one would like to know a great deal more both about the sledging and the places to which the various parties travelled.

J. M. W.

Silver Cities of Yucatan.— Gregory Mason. New York and London: G. P. Putnam's Sons. 1927. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 340. 32 *Illustrations and Map.* 15*s. net.*

A portion of the illustrations to this book are of interest, since some of them are reproductions of photographs of ruins of the Maya period of Yucatan, taken from new angles. The text, unfortunately, does not present equal claims; it consists of somewhat wordy narrative, which rather oddly misses the opportunity of arresting the reader's attention, for, as a day-to-day account of camping out and boat trips, in search of the Maya ruins which Dr. Gann's first-hand stories have rendered so enthralling, these pages should contain material of import. As it is, the uninstructed reader has no means of knowing which (if any) of the ruins visited were new discoveries, nor is the information given about them of serious value.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Eruptive Rocks: Their Genesis, Composition, Classification, and their Relation to Ore-Deposits, with a Chapter on Meteorites.— S. J. Shand. London: Thomas Murby & Co. 1927. $8\frac{3}{4} \times 5\frac{3}{4}$, pp. xx. + 350. 44 *Illustrations.* 20*s. net.*

According to the Preface, this book has been written with a threefold object. First, the wish to clean up the "jungle of rock names"; second, the desire to make the "results and conclusions of petrology intelligible to matter-of-fact people like physicists and chemists"; third, to rationalize systematic petrology in such a way as to interest the mining man. The task is very ambitious, and the path of the reformer in the existing "jungle" is by no means an easy one. Prof. Shand has the invaluable power of expressing himself with the utmost conciseness. His first six chapters are a model of lucid exposition in dealing with the present position of petrographical science—logical in sequence, well balanced, and adequately annotated. Prof. Shand rarely makes a statement without quoting the appropriate authority, and although he has read very widely he does not allow his own clear line of reasoning to be overshadowed by extraneous quotation. Chapter vii., entitled "A System of Petrography," is devoted to the elaboration of his scheme of classification, a quantitative mineralogical one, based primarily on the distinction between saturated and unsaturated rocks. About half the book deals with the application of the proposed classification. It will doubtless arouse a storm of criticism from the present "orthodox" schools of petrology, both European and American, but the system is well thought out, and merits long and close examination. The re-definition of all the well-known (though loosely defined)

rock types and the re-naming of rock types described by various authors, are major points lending themselves to criticism, but inevitable. The weakest point of the whole scheme seems to be that the classification is an artificial or arbitrary one, whereas one hopes that eventually a natural, genetic classification will arise spontaneously when sufficient actual knowledge of the origins of rocks has been accumulated. The author is, perhaps, rather unwise in some of his minor changes, such as the attempt to substitute " inset " for the well-established term " phenocryst." It is also to be regretted that he has passed by so lightly, and without reference to later work, the fascinating subject of the relation between petrographic characters and geographical distribution of igneous rocks. The difficult question of the spilitic rocks is also avoided. The concluding chapter of the book on " Eruptive Ore Deposits " seems rather inadequately to fulfil the author's third object in writing the book. The printers and publishers are to be congratulated on a well-printed book.

L. D. S.

The Founders of Seismology.— Charles Davison, Sc.D. Cambridge: University Press. 1927. $8\frac{1}{2} \times 5\frac{1}{4}$, pp. x. + 240. 11 *Illustrations*. 12*s*. 6*d*.

In 1921 Dr. Davison published in the *Geological Magazine* a series of three articles dealing with the life and work of certain men prominent in the study of earthquakes. In the present charmingly written book he has expanded this idea and given us a comprehensive sketch of the rise and development of the science of seismology, which in modern times has led to such marvellous results in elucidating the main features of the interior structure of the Earth, by means of deductions drawn by mathematical and physical methods from the observations of the character and velocity of earthquake waves within the solid earth. It must not be forgotten that besides its high and ever-increasing scientific interest seismology has also great practical value, since it throws much light on the types of structure in buildings and the plans of engineering works which are least likely to sustain serious damage in seismic regions. This value is abundantly recognized, for example, in such an intensely practical country as Japan, where a great part of modern seismological work has been carried out, as well as along the Pacific seaboard of America.

The science of seismology may be said to have begun about 1760, when the great earthquake at Lisbon had recently directed attention to the subject, the first serious writers being John Bevis, Bertrand, and John Michell, Woodwardian Professor of Geology at Cambridge. The next stage was the work of Alexis Perrey and Robert Mallet in the middle of the nineteenth century, while the modern period may be said to have started in Italy with the erection of Palmieri's seismograph in the Vesuvian observatory in 1856. This was soon followed by the work of Rossi and Mercalli in Italy and of Forel in Switzerland, and the establishment of the important principle of the regional distribution of earthquakes, together with the adoption of a definite scale of intensity, based on the character of the observed effects. Then came the period of intensive study in Japan, by Milne, Ewing, Kikuchi, Sekiya and Omori. Further important results were yielded by the study of the great Californian earthquake of 1906, and by Oldham's work in India. The painstaking statistical work of Montessus de Ballore should also be mentioned.

All of this is sketched by the author with a judicious intermixture of the historical and personal element with scientific explanation. Although Dr. Davison naturally does not say so, it should be emphasized that his own detailed studies of the comparatively insignificant earthquakes of the British Isles have

contributed not a little towards the true understanding of this abstruse but interesting subject, especially in its relation to tectonic geology and the details of rock-structure. The author was, of all men, probably the most competent to write this book, and it is a matter of congratulation that he has thought fit to do so. R. H. RASTALL.

Physico-Chemical Geology.— R. H. Rastall. London: Edward Arnold & Co. 1927. $8\frac{3}{4} \times 5\frac{1}{2}$, pp. viii. + 248. 62 *Figures*. 15*s. net.*

As the author explains in his preface, this book is "an attempt to give in a connected form some account of the application of modern theories of physical chemistry to geological problems." The field is a very wide one, and Dr. Rastall has chosen to deal with an arbitrarily selected portion of it rather than to attempt a survey of the whole. There is thus no reference to modern work on the structure of crystals, or to the electrical theory of matter. Still more marked is the absence of any reference to radioactivity, the study of which has altered so fundamentally our conception of the thermal constitution of the Earth's crust.

Within the sphere chosen, Dr. Rastall writes with the lucidity and directness which we have learned to associate with his text-books. This is particularly so with that half of the book dealing with igneous rocks and with metamorphism. The physical chemistry of rock-weathering is considered in outline; salt deposits and ore deposits form the subject matter of two other short chapters. There is a final, rather inadequate, chapter on colloids.

Here and there the author gives us fascinating glimpses of the wider subjects, some of especial interest to geographers, to which the present work forms an introduction, and indicates upon what a slender foundation some of our current conceptions are based. "In order to account for the high rigidity of the earth as a whole . . . many geologists and geophysicists have assumed an almost unlimited raising of the freezing-point of minerals by pressure, so that the globe as a whole is solid: . . . it is clear that this assumption is in need of revision." It is to be hoped that, in a future volume, Dr. Rastall will attempt also to summarize the bearing of physico-chemical research on such fundamental problems as this. L. D. S.

HUMAN AND HISTORICAL GEOGRAPHY

Les Bas-Reliefs des Batiments royaux d'Abomey.— E. G. Waterlot. L'Art Néo-Calédonien.— G. H. Luquet. (Travaux et Mémoires de l'Institut d'Ethnologie. I., II.) Paris: Institut d'Ethnologie. 1926.

These publications are the two first of a series of memoirs being published by the Paris Institut d'Ethnologie on subjects illustrating the culture of the native races of the French Colonies. The first consists of twenty-three plates preceded by a short introductory and explanatory chapter. These plates, most of them in colour, show the bas-reliefs modelled on the walls of what remains of the royal dwellings of the kings of Dahomey. The reliefs are chiefly allegorical representations of the kings, and warlike events in their lives. This love of allegory is also shown in a series of illustrations of recades, or royal batons or sceptres, examples of which appear in the bas-reliefs. These recades played a great part in Dahomian society, each king and important chief having his own particular one. Fixed to the extremity of the baton was an allegorical subject worked in wood, iron, or copper.

The second memoir is much more elaborate and of more general interest. In fact, it is an important study of primitive art, a subject which M. Luquet has illuminated in many previous contributions to anthropological science. By a most patient and detailed investigation, comparison, and ingenious inter-

pretation he is able to show the origin and meaning of much of the primitive art of the natives of New Caledonia as exhibited in their wood carving, engravings on bamboo, and designs cut in stone. A profusion of excellent illustrations enables the reader to follow every step in his argument. There are no fewer than 241 figures in the text and twenty plates at the end of the memoir, also a map of the island showing in detail the distribution of the petroglyphs. M. Luquet dissents from the view that these stone monuments were the work of an intruding race which has since disappeared. Comparing this Neo-Caledonian art with that of prehistoric times in Europe, his conclusion is that it shows originality in uniting the characteristics which are found separately in the two great periods of the European Stone Age—the palæolithic and neolithic. If not strictly geographical this study is of great ethnological interest, and must compel the attention of all students of primitive art. E. A. P.

The Cambridge Ancient History.— Volume of Plates, I. Prepared by **C. T. Seltman.** Cambridge: University Press. 1927. 9½ × 6½, pp. xxviii. + 396. 25*s. net.*

This long-promised and much-needed volume is primarily intended to illustrate the references to Art in the first four volumes of the History. With expert knowledge and good judgment Mr. Seltman has well accomplished this. Opposite each plate is given an explanation of it containing useful and valuable information regarding the source, significance, and artistic relations of the objects represented. The work is thus much more than a mere addendum to the first four volumes of the History. It becomes an outline of the history of Art from prehistoric times down to the fifth century B.C. It is indeed a fascinating record which any one interested in Art will find informing and inspiring as he turns over page after page of the excellently produced illustrations. Although the critical reader may wish that certain parts had been dealt with more fully, and perhaps feel that some phases are rather inadequately represented, yet when he considers the limitations imposed in the preparation of the volume, he will hardly refrain from giving his full mead of praise for the skilful and balanced way in which the selection has been made and arranged. A study of the series will help him to appreciate how the artistic efforts of their predecessors were combined and unified by the genius of the Greeks to produce the noblest works of Art the world has known. This is forcibly put by Mr. Seltman in his preface, where he says, "From Egypt the Greek might learn portraiture and the making of life-size statues; Scythia could teach him skill in design; Mesopotamia and Assyria might supply wealth of ornament; Minoan Crete exuberant freedom; the North restraint. But had all these traditions met fortuitously elsewhere than in Greece, it must not be supposed that their fusion would of necessity have produced the same result. For if Greece drew them to herself it was she who supplied from her own incomparable genius the life, the magnetic force that distinguishes from all other arts the art of Greece." No doubt the full expression of that incomparable genius will be illustrated in the promised Second volume of Plates, the publication of which, it is to be hoped, will not long be delayed. E. A. P.

Piri Re'is.—Bahrije. Das türkische Segelhandbuch für das Mittelländische Meer vom Jahre 1521.— Paul Kahle. Berlin and Leipzig: Walter de Gruyter & Co. 1926. 10¼ × 7¼, vol. 1 (text), part 1, pp. 4 + 64 plates; vol. 2 (translation), part 1, pp. xlviii. + 88.

These form the first of what will presumably amount to five such parts in each volume, the whole to be followed by a third volume containing textual

criticism, commentary, and studies on particular aspects and problems of the work. At this stage, consequently, it is sufficient to draw attention to the character and special features of the book itself. The author belonged to a seafaring family of distinction, in that century when the naval power of Turkey was brought to its most formidable height by the genius of so many famous captains. The object of his *Bahrîya* is indicated in the title. The chief interest of the work for most students will lie in the maps appended to each section, which were unquestionably based on contemporary Italian charts of a type of which few examples have survived, and for which newer and more up-to-date maps from the same sources were substituted in later manuscripts of the book. It would do less than justice to the author not to refer also to the accurate and full descriptions which accompany the maps, based in part on his personal experience, but also, in the editor's view, indebted to European sources. The rapid decline of Turkish sea-power after the sixteenth century was responsible for the preservation of this mediæval chart-book, unique in Turkish literature, whereas its European prototypes and contemporaries were discarded and destroyed in the advance of knowledge and technique. The present parts cover about half of the Ægean Sea, or 28 out of the 130 sections in the entire work. Volume **2** contains also a brief introduction, into which the editor has had the excellent idea of inserting the valuable section on Turkish ships and their equipment from the works of the later Turkish encyclopædist, Hajji Khalfa. In fine, this is a book not to be overlooked by the student of mediæval geography. H. A. R. G.

GENERAL

The Life of Sir Albert Hastings Markham.— **M. E.** and **F. A. Markham.** Cambridge: University Press. 1927. 9 × 5¾, pp. x. + 262. *Portrait and Illustrations.* 15*s. net.*

Markham's early years in the Navy were a good preparation for the arduous tasks which he set himself later in life. It is of interest to note in these days of courses and classes that his first eight years in the Navy were spent entirely afloat, and that these did not unfit him in any way from becoming, if not a great man of science, at least one capable of taking a scientific part in exploration.

The early chapters of the book are full of interest in China. In 1872 his taste for Arctic exploration was given its first chance, and it was fortunate for him that questions of delicacy of food and living were no deterrent to him. To a non-smoker, however, as he was, with a hatred of tobacco, it must have been a severe trial to occupy the accommodation in the whalers which he was obliged to put up with.

The chief interest lies in the chapters describing the expedition of the *Alert* and *Discovery*, and although these are written with no great aim at scientific description they afford an example of cheerful work under circumstances of greater hardship in the way of shortness of food and general lack of comfort than are now usual—an example which should be useful to all young men. The walk of Captain Chase Parr is well described, and the constancy and devotion of Markham himself is followed with a most sympathetic pen.

The journey to Hudson's Bay, quite slightly described, should be followed with a larger-scale map than the writers give.

One of the most remarkable things in the book is the fact that wherever Markham went he found scope for expeditions not only of interest for himself but in which he could carry his officers with him. All the part on the Pacific Station and again that treating of the Mediterranean give us a keen sense of

his desire to acquire more knowledge of many things and of his intense interest in the world. This, again, must be an incentive to those who have the good fortune to go abroad on ordinary occasions to seek out, as Markham always did, places of real interest.

It is not within the province of this review to speak of the *Victoria*—a disaster which showed Markham to be of tender heart, and from which he emerged a much older and graver man. W. E. G.

Die Geographie: Ihre Geschichte, Ihre Wesen und Ihre Methoden.—Alfred Hettner. Breslau: Ferdinand Hirt. 1927. $9\frac{1}{2} \times 6\frac{1}{4}$, pp. viii. + 464. *RM.*22.

In his preface Prof. Hettner states that his book represents in many ways his life's work; is not based upon reading but has been lived. He goes on to say that though he has striven for scientific objectivity, yet the book is a personal and in some degree a subjective one. He has sought to take account of all the main tendencies of geography, and has therefore included a short history of the subject. But he regards methods—of teaching, of research, of representation—as of much greater importance than definitions of the scope of geographical science, and has made these topics his central theme.

These quotations indicate the difficulty of the task which he has set himself. To make a record of personal experience and development interesting—to write, that is, an *Apologia* in Newman's sense—requires the touch of genius which is the gift of the high gods and comes not through sweat and toil. To attempt to combine such a record with a detailed discussion of the history, content, and methods of a specific science is perhaps an indication of a fatal lack of humour. There is certainly not a little professorial solemnity in the book. It is difficult to avoid a smile when we are told that atlases may be divided into hand atlases and school atlases; that the former are generally larger than the latter, but that some hand atlases do not differ greatly from school atlases in this respect; and that then their characteristic feature is the absence of the didactic outlook necessary in works designed for school use. Under the heading of geographical literature we learn that "English ladies and others" have published much trash in the form of travel books; the form of the sentence, unfortunately, does not make clear whether it is the sex or the nationality of the "others" which is held responsible for this deplorable result.

In addition to much labouring of the obvious there is a certain amount of repetition, due to the fact that some sections have been reproduced from the author's articles in the *Geographische Zeitschrift* and elsewhere. The reader's sympathies are also apt to be alienated by the very outspoken criticisms of the writings of other geographers. In most cases the names of the books or articles criticized are not stated, while the author is careful to give references to his own books and papers in full; this produces an impression of a lack of courtesy in addition to imperfect success in the "striving after scientific objectivity."

It would be unjust, however, not to emphasize the fact that the book discusses subjects of permanent interest to geographers, especially to those engaged in teaching and in drawing up syllabuses and programmes. The sections on the place of geography in various types of schools, and as a subject in a university curriculum, contain much sound sense, and being based on long experience demand careful consideration. Further, the views of one who has himself added notably to the content of geography on such subjects as methods of research, the relative importance of field observation and the examination

of written records, the relation of geography to the sciences from which it obtains much of its material, and so on, must necessarily be of importance, and the book will take a place among standard works of reference.

M. I. N.

THE MONTHLY RECORD

Prehistoric Agriculture in England.

In a paper contributed to the *Journal* (**61**, 1923, pp. 342–66) on Air Survey and Archæology, Mr. O. G. S. Crawford showed how the traces of early agricultural systems, previously almost unsuspected, appeared on air photographs of the downs of Southern England. The whole subject of prehistoric agriculture is further treated by Mr. E. Cecil Curwen in a fully documented article in the September number of *Antiquity*. Concerning the introduction of wheat into this country, grain is said to be associated with a neolithic site at Rothesay, with an Early Bronze Age site in North Berwick, and is found frequently in Early Iron Age sites. The evidence of implements, sickles, and "saddle-querns" also supports this early introduction of cereals. A primitive instrument, the "foot-plough," a variant of which, the "caschrom," is still employed in the Hebrides, probably preceded the plough of the Bronze Age in general use, itself being preceded by mattock and hoe. The nature of the field system, as was pointed out in the article quoted above, is revealed by the traces of lynchets or balks. These banks were produced at right angles to the hill slopes solely through the ploughing of the surface, and are therefore complete evidence of the practice of agriculture. The air photographs of early sites reveal a field-system entirely different from the mediæval Saxon three-field system. The latter consisted of long narrow co-terminous strips. The so-called Celtic type had three varieties: first, strips across the hill slope, not co-terminous, sometimes divided transversely; a second variety running similarly down the hill; and a third of square-shaped fields fitting irregularly into each other, probably of the Roman period. The Saxon system, contrary to what has often been argued, must therefore have been introduced, probably originally from the valleys of the Po and Danube. It is suggested that the difference was brought about by the use of a more efficient plough. The Romans were accustomed to ploughing along and across their fields, consequently the latter were approximately square. With an efficient plough, the long furrow was more economical. So active were the agriculturalists of the Early Iron Age, that traces of their Bronze Age predecessors have been obliterated where one might expect to find them. They are to be found, however, in the less sought-after Dartmoor area. Here excavation has brought to light groups of hut circles of varied plans, associated with Bronze Age finds. Some of these groups are surrounded by circular walls, others have approximately rectangular enclosures, arranged in rows and showing faint signs of lynchets. The transition to this latter type probably followed upon the replacing of the mattock or digging stick by the foot plough. Examples of the earlier types, which may represent the beginning of English agriculture, are to be seen at Shaugh Prior and Standon Down; of the later, at Kes Tor, Batworthy, and Foale's Arrishes, near Rippon Tor.

The Salt-marshes of Croisic.

During researches into the life of the salt-marshes of Croisic, M. Aphonse Labbé studied the question of the formation of the marshes themselves, the

results appearing in *Annales de l'Institut Océanographique*, vol. 3, fasc. 7. The salt-marshes lie between the cliffs of Guérande on the north—gneissic rocks 35–40 metres high—and two rocky islands, joined by sand-dunes, Croisic and Batz, on the south. The channel, approximately 6 kilometres long, is blocked by sand-dunes, and filled for a large part with the marshes, though at the north-west end there is an area accessible from the sea known as the "traict." The region has been subjected to frequent upheavals and regressions, and it is probable that the line of the Guérande cliffs represents the limit of post-neolithic marine transgression. The "traict" was thus probably a channel lined by islands at the Roman Conquest. The writer endeavours to support this conclusion from the evidence of ancient writers, particularly Ptolemy and Cæsar. By identifying Ptolemy's position for the northern estuary of the Loire with the cliffs of Guérande, he obtains the identification of "Insula Arica" with the island of Batz. He further believes that Cæsar's naval battle with the Venetii took place in the "Trajectus," which, and not the Gulf of Morbihan, was the "mare occlusum" of the Commentaries. From the latter he also deduces that at this period, the present regression of the sea had begun. These conclusions are tentative, but evidence of Roman salt-pans, galleys, and villas is adduced to show that the marshes then extended only 150 metres from the coast where now they are approximately 1 km. in width. From the names Clis and Lencly, M. Labbé believes that the original channel lay between these two places, and that it was shut (*cludo*) during Roman–Gallic times, with the growth of the sandy peninsula of Penbron. Terms employed in the local industries connected with the marshes suggest a Roman–Gallic origin. The invasion by the sand-dunes appears to have been in progress between the seventh and sixteenth centuries.

The marshes are largely composed of the mud brought down by the Loire and carried twice daily into the "lagoons" by the tides. The actual formation of the banks and pans can be ascribed (1) to the folding of the underlying sands by lateral pressure probably produced by the down-faulting of the Croisic–Batz ridge, and (2) to the hydrographic *régime*. The tides, penetrating the mud at points of least resistance, deposit their load on the banks and, in going out, scour their beds. High tides overflow the banks and thus form salt-pans, which are colonized by a fauna. The banks and "pans" used in the salt industry are therefore of natural origin. The conclusions drawn from the physical history of this area assist in establishing that the salt-water fauna is a relic of the Gallo-Roman epoch. It is, further, of recent, but not of fresh-water, origin, the probability being that the fresh-water fauna is derived from the salt.

Swiss Glacier Observations.

The forty-second annual report on the periodical variations of the Swiss glaciers by P. L. Mercanton (*Die Alpen*, 3, 1927, pp. 167–200), shows that there are indications of a new advance, though, as the meteorological conditions in 1926 were exceptional, the advance may be due to them alone. The snow-fall of the year was particularly great and, in general, the winter months were warmer, the spring and summer months cooler, than the average—conditions favourable to the growth of glaciers. In all, 95 glaciers were observed: of these 50 were advancing, 8 were stationary, and 37 in retreat. Compared with 1925, this is an increase of 33 per cent. in the number of advancing glaciers. In each of the basins of the Reuss, Linth, Rhine, Inn, and Adda, the number of glaciers advancing exceeded those stationary or in retreat. In the Rhône basin, of the 38 glaciers observed, 17 were in advance, 5 were stationary, and

16 in retreat. The majority of the glaciers observed in the basins of the Aar and Tessin were, however, in retreat. The Rhône glacier had advanced approximately 3·5 metres, and has now regained the 2000 square metres lost since 1921.

Herr Erkes' Explorations in Central Iceland.

This energetic explorer, whose journeys have been referred to from time to time in the *Journal*, carried out the eighth of the series between June and September 1926, and he gives a short account of the main results in *Petermanns Mitteilungen*, Heft 5/6, 1927. From his first journey in 1905 Herr Erkes has always tried to keep away from the frequented tracks, and much of his work has been done in the region of the Odádahraun lava-desert, the adjacent boulder-strewn tract of the Sprengisandur, and the uplands to the north. Some years ago he had convinced himself of the inaccuracy of existing maps of this part of the island, and in 1924 he set himself the task of their rectification, but was unable to do much owing to bad weather. In 1926 he returned to the task, and his network of routes covered most of the ground from the Vatnajökull and Hofsjökull in the south, to the Eyja fjord in the north. He first visited an uninhabited eastern branch of the stream flowing to Eyja fjord, and found that the ascent from its head to the central highland involved a climb of only 150 metres as against the 700 of the well-known Vatnahjalli at the head of the main valley. The highland itself too proved to be not an even plateau, for the original covering of basalt has been so broken up that its remains form innumerable rock ridges of irregular height. Climbing one of the highest elevations (1100 metres), he gained a clear view over the whole surrounding country, and from subsequent exploring trips he was able to lay down the courses of the various deeply cut ravines of the northward-flowing streams, some of which come from much farther south than has been supposed. The sides of some are extremely steep and difficult, but one was found which offers a gradual ascent to the Sprengisandur, and whose floor, unlike most, supports good pastures in places. Herr Erkes also crossed the Odádahraun to the Askja volcano, which, after a long period of quiescence following its well-known outburst in 1875, has renewed its activity since 1921, and had been once more in eruption in June 1926, according to various reports. Reaching the lake on the summit of the mountain, he found that the new eruption had formed an island 40 metres high in the lake, but that the vent appeared to be closed. The several lava-streams of 1921–23 had given to the surrounding surface a much more jagged appearance than when Herr Erkes had first seen it. The traveller, who is sixty-two years old, does not intend to return to the scene of his labours.

Stefano Buonsignori and early Maps of Tuscany.

A notable feature in Italian sixteenth-century cartography is the wide-spread use of maps for the decoration of the walls of public buildings, the best-known examples being those in the Sala dello Scudo at Venice and the Loggie di Rafaele at the Vatican. Some are still little known outside Italy, but information is gradually being made available through the work of Italian students. Two maps of Tuscany, painted in 1589 by Don Stefano Buonsignori in the Galleria degli Uffizi at Florence, are described in *L'Universo* for June 1927 in a well-informed article by Lina Genovié. Buonsignori has been known chiefly for his striking plan of Florence of 1584, described by Del Badia in 1898. The two maps now described (the larger of which is about 24 feet long) were long hidden from view by other decorations of the hall, but were uncovered in 1906.

One is of the " Dominio Fiorentino," the other of the " Dominio Senese," and both were enlarged and extended versions of engraved maps of the same districts by the same author, first published in 1584, and several times re-issued (*e.g.* in the Life of the Grand-duke Cosimo I. by Aldus Manutius, and in some of the later editions of Ortelius). The writer analyses the wall paintings in considerable detail, and then does the same for the engraved examples, which naturally contain much fewer names. The map of the Florentine dominions shows on the whole the greater accuracy, and in particular marks an improvement on its predecessors in the more correct direction given to the Apennines, to the course of the Arno, and the profile of the coast. The hydrography is very well shown, but the mountains in more primitive fashion. In some ways the original engraved maps are superior. As regards the sources of the maps, while there are certain indications that Buonsignori knew and used the previous maps of Bellarmato (used also by Ortelius) and Orlandi, it is evident from the improvements he introduced that he drew to a large extent on original sources. The paper is accompanied by reduced facsimiles, both of the painted and engraved versions : the author also traces the influence of Buonsignori's maps on those of his successors—Magini, Rosaccio, etc. It should be mentioned that he painted some of the maps on the panels of the *Guardaroba* in the Palazzo Vecchio in Florence, which had been left unfinished by Egnatio Danti, cosmographer to Cosimo I., and author of the Italian series of wall maps in the Vatican gallery.

ASIA

Archæological Research in Syria.

A brief note in *La Géographie* (March 1927) gives details of a recent French archæological expedition to Al Jazira north-east of the Euphrates. We have also received from Sir Arnold Wilson a short abstract of a further article in the review *Syria* (Paris, 1927). The expedition, directed by Father Poidebard and M. Maurice Dunand, had as its object the investigation from the air and on the ground of the traces of ancient trade routes which Father Poidebard had observed from the air in 1925. These routes linked the Tigris and Euphrates, particularly along the line of the Nahr el Khabur. They can be traced by the mounds, wells, and ruined bridge-heads along their courses. The other objects were the examination of the " Tells " between the upper Nahr el Khabur and the 'Iraq boundary, and the trial excavation of Assyrian sites. In all this the expedition was successful. Thirteen ancient caravan tracks were traced. What appeared from the ground to be deserted tépés irregularly distributed were seen from the air to be a carefully constructed series of road posts at fairly regular intervals along the routes. Five previously unrecorded Roman camps were discovered, three of which were unrecognizable from the ground. Three were along the Nahr Jaghjagha, to the south of Nisibin ; two on the frontier of Septimus Severus, between El Haseke and the Jebel Sinjar. A large collection of Assyrian pottery was brought back, which enabled all the principal " Tells " and ancient routes to be dated. Tell Hamidi, 65 km. north of the El Haseke, was trenched and successive levels from prehistoric times revealed. Sufficient material is now available for the study of the Roman frontier between Palmyra and the Tigris.

Formosa : Erratum in Mr. de Bunsen's paper.

An error occurs in the title of one of the plates illustrating Mr. E. H. de Bunsen's paper on Formosa in the September *Journal*. The title of the lowest of the blocks facing p. 276 should read " Paiwan savage outside slate house," and not *slave* house, as it is given there.

AFRICA

The Orange River Region.

The physiography and geology of the Orange River area in relation to its past climates are discussed in two papers contained in the *Transactions* of the Royal Society of South Africa, 14, 1927, pt. 3. The first, by Dr. W. A. Humphrey, deals with the short tributaries which join the south bank of the Orange River between Viols Drift and Ramans Drift. Their length varies from 8 to 10 miles; the gradient of their lower courses are steep, so that no alluvium or gravel beds are to be found. Eight miles or so up-stream, however, the gradient becomes lower, and the valleys, merging in the high ground, are filled with sand which has originated much farther to the south. At present three longer streams have succeeded in maintaining their courses and form the general drainage system. The writer believes that the short streams originally had greater extension towards the south, and that heavier rainfall must have enabled them to cut out their beds, though present climatic conditions have obtained from very remote times. The present process may be witnessed in one of the longer rivers, the Brak. Its middle course lies through Twenty Mile Plain, which is considered to be an ancient river valley gradually filling up from remote times with sand. Sand from this plain is even being blown across into the immediate valley of the Orange River. In July 1925, for the first time in the memory of the Hottentots, water reached the Orange River through this channel. The Kammas river, which reaches the sea south of Port Nolloth, is an example of a river filling its bed up through its own action in forming sand plains during floods, through which it has afterwards been unable to force its way. It is probable that the surface of this area has been exposed to denudation since the deposition of the lower Karoo beds.

In the other paper, Dr. S. H. Haughton contributes some notes on the lower 60 miles of the Molopo river and the Aughrabies Falls on the Orange River. The Molopo in this section falls 1150 feet altogether, but more than half this fall is in the last 8 miles. Gravel river terraces, upon a peneplain surface, have been noted at varying heights above the bed, and it is probable that formerly the river was evenly graded to its junction with the Orange River at a point now below the Aughrabies Falls. With the regression of the Falls, the Molopo cut back its course. The tributaries below the Falls point to active downward erosion of the main stream subsequent to Upper Cretaceous times, though the cause of this rejuvenation is not clear. From the Molopo gravels it is held that humid conditions continued much later than early Tertiary times, lasting longer than they did farther west.

AMERICA

Lakes due to Landslides in the Great Basin.

The part played by landslides in the formation of lakes in the north-western Great Basin of North America is described, with illustrations, by R. J. Russell in University of California Publications in Geography, vol. 2, 1927, pp. 231–54. An area of approximately 10,000 square miles is covered with a thin sheet of basalt above andesite agglomerate and tuff. As the rivers cut into their canyons, the resistant lava is undermined. Where gradients are not steep, the walls are protected to some extent by talus, but with steep gradients the talus is removed and the undermining proceeds rapidly. Most of the material thus eroded is removed by the streams, but occasionally slides occur which, blocking the beds completely, form lakes. Examples of such lakes are given from the

Warner range of north-east California. Clear Lake, on Mill Creek, is half a mile long, with a maximum width of 200 yards near its western end, where it has a depth of 90 feet. The longitudinal profile of the lake fits exactly into that of the creek above and below. On the lower walls on either side of the canyon scars of newly exposed rock are visible, with blocks of basalt, tuff, etc., up to 40 feet in diameter at the foot, similar to the irregular hummocky mass of the dam formed by two slides. Firs and pine established on the dam point to its formation about a century ago, and there are said to be local Indian traditions of the landslides. A small delta has been formed at the head of the lake. The two slides were apparently simultaneous, and may have been started by an earthquake shock. On emerging from the dam, the channel falls abruptly 60 feet, and then over cataracts into a gorge. The falls are said to have receded 30 feet in the last fifteen years, but this rate is not likely to be maintained. A regression of half a mile would be necessary to tap the lake. Another lake, Lost Lake, is apparently much older, as it has been nearly half filled by the delta, a grassy meadow, though the drainage area of the stream is less than one quarter that of Mill Creek. The Pine Creek Basin Lakes have been formed in a "headwater basin" which narrows from 2 miles in width to a canyon. Landslides are frequent, and small ponds form in the pits: where larger slides have crossed the basin entirely, several lakes have formed. The lakes often dry up completely in the summer, though the creek, aided by springs, is perennial. Elsewhere in this area, extinct landslide lakes can be observed. Mill Creek, below Clear Lake, flows to join the Pitt River across what was once the bed of a lake 6 miles long and $2\frac{1}{2}$ miles wide, held up by a landslide of approximately 45 million cubic yards. The shore-line of this lake may be traced at the outlet, 164 feet above the present channel.

POLAR REGIONS

Relics of the Franklin Expedition.

The Hydrographic Department of the Admiralty has recently published a chart (No. 5101) which will have a special, though melancholy, interest for all who have followed the history of Arctic exploration, inasmuch as it recalls the ill-fated Franklin expedition. The chart has been compiled by Lieut.-Commander R. T. Gould, R.N., who has made a careful investigation of the available records; on an outline of King William Island and its vicinity he has shown the probable drift of the *Erebus* and *Terror*, the positions of graves and places where relics of the expedition have been found, the probable line of retreat by sledge and boat after the abandonment of the vessels, and other information that he has been able to collect. All information based upon personal observations of various British and American explorers is shown in red, while that depending on Eskimo reports obtained by these explorers is in blue. The names of the explorers are given, as are also the dates of their expeditions.

This chart can be obtained from Messrs. J. D. Potter, 145, Minories, E.C., for 3*s*.

Some Problems of Polar Geography.

In his Presidential Address to Section E (Geography) at the Leeds meeting of the British Association, Dr. R. N. Rudmose Brown gave a valuable survey of the present position of Polar exploration, and set out some important conclusions as to the future development of Polar lands. At the outset he emphasized the fact that, despite the recent advance of the human element in

geographical work, the basis of geography must always be a knowledge of the surface features of the Earth, and he described the Polar regions as an "uncomparable field of observation for all sides of pure geography." The Antarctic offers the greatest scope for exploration: in particular the margin of the continent between Enderby Land and Coats Land, the western shores of the Weddell Sea, and the gap between Charcot and Edward Lands. Most of this work can be satisfactorily done only by land parties. Various circumstances have confined exploratory and scientific work to Graham Land and the Ross Sea region, though even here there remains many problems for solution. It is fairly certain, for instance, that structurally, the range whose course is outlined by South Georgia, the South Orkneys, and the heights of Graham Land is allied to the Andean system; but the relations of the Victoria Land "horst," and the ultimate trend of the Maud Mountains have yet to be determined. Much work in oceanographical and meteorological problems also remains. The importance of the varying amount of sea-ice and the intensity of the currents in producing oscillation of climate in South America has already been established by the correlation of data. In the Arctic, less purely exploratory work remains to be carried out. Nicholas Land is yet little known; but the main work lies in settling the true nature of those "lands" which appear from time to time in the Polar ice on explorers' charts, such as Crocker Land, Plover Land, and Giles Land. There are problems of the nature and age of the Arctic basin to be solved, and of the circulation, supply, and fluctuation of the Arctic sea-ice, particularly in the Greenland Sea, which have important bearings upon meteorology. In discussing the equipment now at the disposal of explorers, Dr. Rudmose Brown points out that the true scientific value of aeroplanes lies in their possibilities for survey work, such as has been suggested, for example, along the east coast of Greenland. At present, motor sledges give an increased chance of success, but not being absolutely reliable, and unlikely to become so, the danger of a tragedy through a breakdown will always be present. Scurvy is now inexcusable except perhaps upon a land journey in the Antarctic.

The last section of the Address, and probably that of most general interest, is devoted to a study of the future settlement of Polar lands, in the Arctic especially, for the Antarctic presents no resources for exploitation. The old fear of the Arctic, largely bred from ignorance, is passing. Many travellers, notably Stefansson, advocate and practise "living off the land," which is not however always possible or desirable for scientific expeditions. In the past, fur and oil have attracted men to the Arctic, but the destructiveness of modern weapons will make it increasingly necessary to rely upon raising animals rather than on hunting. The picture painted by Stefansson of the future of the Arctic prairies as grazing-grounds for reindeer and moose is perhaps too bright, but it rests upon undoubted facts. Some years ago five hundred reindeer were introduced into South Baffin Island, where they all perished. This, however, may be accounted for on several grounds—the unsuitability of the particular type of deer, the dampness of the climate, and the depredation of wolves. At a conservative estimate, based upon experiences in Alaska, 50 million reindeer and several times as many musk-ox could be supported upon the Arctic tundras. The significance of this is that, with the increase of world population, the herdsman, displaced from temperate lands by the farmer, will find there a refuge for which he can never be challenged by the farmer. There is no real evidence that white peoples are suited for permanent tropical settlement, so that it may be supposed that the tide will set northwards, towards a source of vast supplies

of food. At present there is no experience of family life in the Arctic, but if Huntington's criterion of "low mean daily temperature" as the best for human activities is accepted, the prospects are not unfavourable. The Norse colonies in Greenland suffered from obvious disadvantages which would not be repeated. "Such is the legitimate forecast, as I see it, of the *outer* rim of the Arctic of the future with its prosperous, though scattered, colonists of pastoral interests and its fur farms here and there supplying high-priced Arctic furs in limited numbers. But the settlement must wait until the pressure of population on the world's resources is even greater than it is to-day."

OBITUARY

Major-General Sir J. R. L. Macdonald.

WE record with great regret the death, on June 28 last, of Major-General Sir James Ronald Leslie Macdonald, K.C.I.E., C.B. After passing through the Royal Military Academy he was gazetted to the Royal Engineers in 1882, served in the Hazara campaign, and gained experience in Indian railway organization. His work in Africa began in 1891, when he was appointed to survey the railway line from Mombasa to Uganda. Later, before the direct assumption of rule by the British Government, Macdonald served as Acting Commissioner. After holding other posts in East Africa and India, he was appointed to command a military and exploratory expedition, which was dispatched from Uganda in 1898 to penetrate the country between Lake Rudolf and the Sudan border. His next important appointment was to the command of the military forces which accompanied Sir Francis Younghusband's mission to Lhasa in 1903–4. For these services he received the K.C.I.E. He retired from active service in 1912. Sir James Macdonald had been a Fellow of the Society since 1891, and had given an account of his African expedition at a meeting in June 1899 (see *Journal*, 14, pp. 129 *et seq.*). An account of his previous work in East Africa had been given in his book, 'Soldiering and Surveying in British East Africa' (1897), which is a valuable record of an important stage in the establishment of British authority in that part of the continent.

Prof. C. R. Dryer, M.A., M.D.

We regret to record the death in March last of Dr. Charles Redway Dryer, who was elected a Fellow of the Society in 1905. Dr. Dryer began his career as a teacher of science in Fort Wayne, Indiana, from 1877 to 1890. For many years he had assisted the Indiana Geological Survey, and in 1893 he became Professor of Geography and Geology in the Indiana State Normal School, a post he held until 1913. Dr. Dryer was the author of many local studies and also of works on general physical and economic geography, and did much to advance the status of geography in the United States.

CORRESPONDENCE

The Thames-Rhine Problem.

I CORDIALLY welcome Prof. Dudley Stamp's valuable article on the Thames–Rhine problem, and its large agreement on the essential point. There are two

chief differences between us. The first is whether the warm-water fauna of the Coralline Crag Sea entered it *viâ* the English Channel or across the southern Midlands and the Thames Basin. The arguments for the English Channel route are as follows :

1. There is no evidence of marine Pliocene deposits between the Lower Thames and Western Cornwall ; whereas the English Channel was certainly occupied by the sea, as shown by the marine Pliocene deposits far up the Channel on the French coast and at Beachy Head. Prof. Stamp's map, Fig. 3, shows the Diestian Sea extending up the English Channel to south of Dungeness ; and deposits of the same age occur on both sides of the Strait of Dover (near Folkestone and near Calais).

2. Dr. Woolridge's work shows that the 600-feet Pliocene marine deposits in North Kent were not accompanied by tilting of the country. Therefore the same submergence would have happened around Dover, and an arm of the Diestian North Sea would have reached the English Channel. I need hardly say that I welcome Dr. Woolridge's work, as I have long urged the Pliocene age of some gravels and of a marine plain in Essex.

3. If the North Sea had received its warm Coralline Crag fauna through a sea that extended across the west of England into the London Basin, that basin should have received its Pliocene sediments from the west ; yet they cannot be explained by a western origin. Prof. Boswell tells me that he has additional evidence of the easterly derivation of this material. His support (as quoted in *Geogr. Journ.*, July 1927, p. 56) to the possible discharge of some East Anglian rivers to the English Channel is conditional on this arrangement being consistent with the eastern source of their material. These sediments may have been derived either from redeposited Miocene beds or from the existing Lower Pliocene, and have been carried westward before the full development of the Coralline Crag Sea ; and this material may have been supplemented from the east when the Strait of Dover was again raised into land during the time of the Red Crag.

4. The absence of western sedimentary material indicates that the Pliocene Sea of the London Basin, which narrowed from the coast inland, was closed to the west. The contemporary sea in the English Channel, on the other hand, received material from the western end which was transported eastward as far as, and even through, the Strait of Dover.

Regarding the Sangatte granite, I am much obliged to Prof. Stamp for the information that it is so rare and in such small pebbles. Prestwich reports that in a " short visit to the cliff " he found " two pebbles of a red granite, which may have been derived from the granitic districts either of the Cotentin or of the Channel Isles " (*Q.J.G.S.*, **21**, 1865, pp. 440, 441). My reference to the ice-carried boulders was not, however, based on Prestwich but on Clement Reid (' Submerged Forests,' 1913, p. 68), who, on the basis of " one erratic block, probably derived from the Channel Islands " at Sangatte, says " The icy English Channel must therefore have met the icy North Sea some time during the Glacial Epoch."

Prestwich's opinion that the granite which he found at Sangatte came from the Channel Islands, and that therefore the Strait of Dover was occupied by the sea before the time of the mammoth, is confirmed by the work of Mons. G. Dubois. For that author's pebble of " rose-coloured white-mica granite " at Sangatte was associated with marine shells and was found beneath a marine sand ; and he describes at Étaples, farther west, more marine sands, and in them he found a " galet " of rose-coloured white-mica granite, of the type of

that of the "Îles Anglo-Normandes" (*Ann. Soc. géol. Nord.*, vol. **46**, 1921, p. 42).

The second important difference between Prof. Stamp's view and my own is as to the cause of the diversion of the Thames to the English Channel. Prof. Stamp recognizes that the Thames waters discharged past Dover to the English Channel, owing to that ponding of water at the southern end of the North Sea to which he attributes the enlargement of the Strait of Dover. Prof. Stamp attributes this diversion to an hypothetical ice-barrier which is becoming increasingly dubious. I prefer to attribute it to the ridge, which actually exists, though submerged, from East Anglia to Holland.

Part of the apparent divergence of view between Prof. Stamp and myself is due to my effort to avoid use of too many geological time-terms in the *Geographical Journal*. I should be glad therefore to make clear the exact dates to which I assign the various changes in the topography of the Dover district. (1) The Miocene was the natural time for the lowering by denudation of the chalk ridge over the site of the Strait of Dover. (2) Just afterwards, in the Diestian, a 600-feet submergence would have connected the North Sea past Dover, or possibly east of the Boulonnais, with the English Channel. (3) The level of the Coralline Crag Sea was somewhat lower, but its warm-water fauna shows that it was open somehow to the south. (4) In the succeeding Red Crag Dover Strait was turned into an isthmus; the sea to the north became colder and lost its southern fauna. (5) In the early Pleistocene the Strait of Dover was at times a strait and at times an isthmus.

I agree with Prof. Stamp that the connection with the rivers of the Wash and the Rhine was post-Pliocene. During most of the Pliocene the two river systems were separated by the North Sea; and if the river connection had been severed in the Pliocene the fish would have been expected to have developed into at least distinct varieties. I dissent from the view that no life can have survived during glacial times in England to the line shown in his Fig. 1. It is important to distinguish between the two limits of glacial deposits. The country to the west of the line of moraines which crosses England from Flamboro' Head past York and the Birmingham district to South Wales is universally agreed to have been mostly covered by an ice-sheet. Prof. Stamp's map shows the distribution of the boulder clay and various water-deposited gravels, the formation of which is still in dispute. The work of Mr. M. A. C. Hinton, proving the continuous evolution of the mammal life of the south-east of England throughout glacial times, and of Mrs. Reid, in confirmation of the view of Clement Reid, that the Cromer Forest Bed flora was practically that of the present time, show the survival of the pre-glacial fauna and flora in parts of the country outside the moraine line.

Some instructive letters which I have received since the publication of the paper indicate that the immigration into Britain of continental plants and animals may have been more extensive through East Anglia than through Dover. Thus Mr. Good tells me that there is a group of plants found in the north-east of France which is present in East Anglia but not in Kent. Support to this view is furnished by some Crustacea. The relative importance of the two routes requires the marshalling of all the facts, and I hope that the Natural History Societies of the south-east of England will collect and discuss the available biological evidence.

J. W. GREGORY.

Problems of the Libyan Desert.

In discussing the possible site of the "Tortoise Marshes" of Ptolemy in the third section of my paper under the above title, printed in the *Geographical Journal* for September (pp. 209–211), I made a bad slip in taking the true latitude of Alexandria as 32° 12′, instead of 31° 12′. Ptolemy's value of 31° was really only 12′ below the truth. The rectification of my mistake will lead to a probable latitude for the "Tortoise Marshes" 1° lower than that at which I arrived in the paper; but it will not, I think, invalidate the suggestion of Kufra as a possible site.

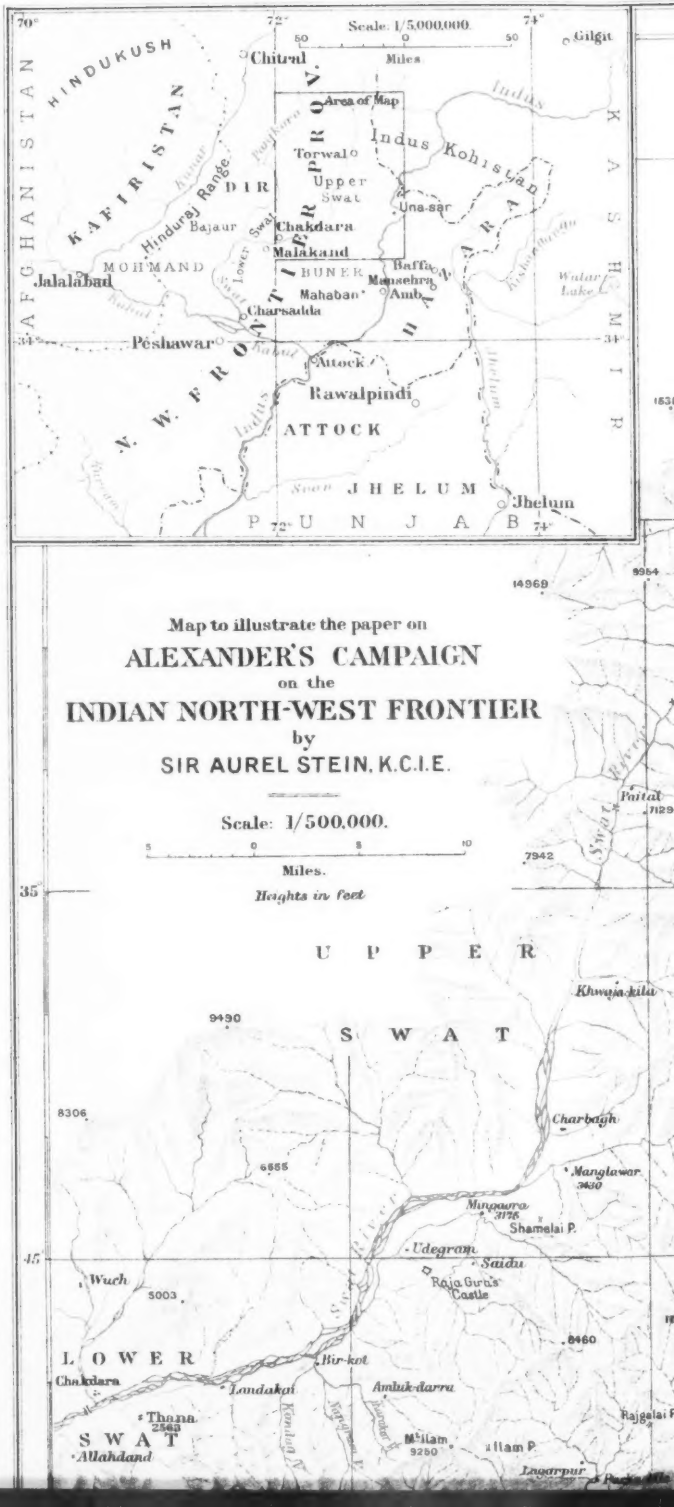
It has further been pointed out to me by a friendly critic that my translation of *in mediterranea* as "into the Mediterranean" is incorrect, and that what Ptolemy meant was that there were two rivers flowing "in the middle land"—*i.e.* in the interior. This clears up a difficulty which had puzzled me considerably.

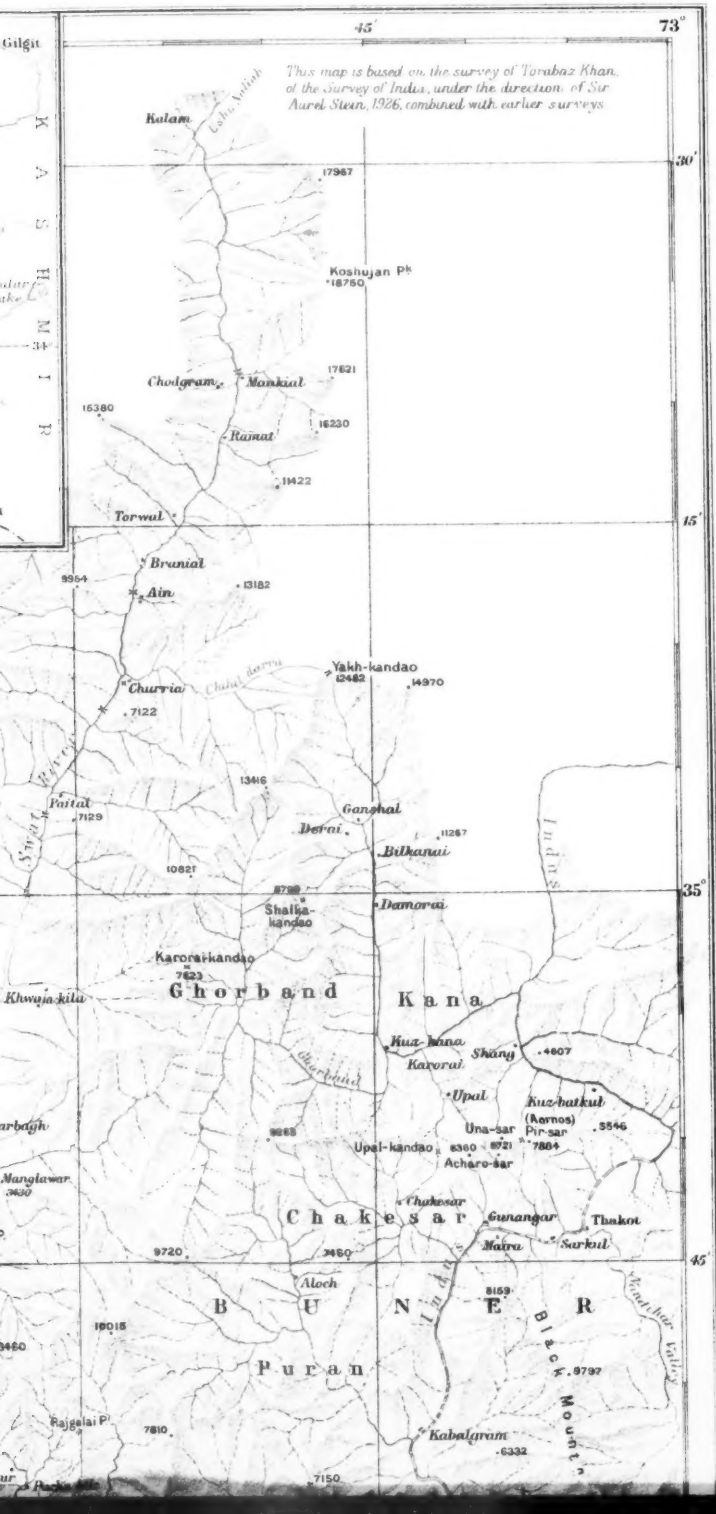
May I take this opportunity of correcting also two printer's errors in the first section of my paper, which appeared in the July number of the *Journal*? On p. 31, line 18, "north-westerly" should read "north-easterly"; and under the bottom photograph opposite p. 32, "S.S.W." is a misprint for "S.S.E."

JOHN BALL.

Cairo, 4 October 1927.

Another correspondent has called our attention to the mistranslation, remarking that the original Greek ἔν τῇ μεσογείῳ is conclusive. He remarks also that Allen and Thompson (Expedition to the Niger in 1841) had identified the Gir with the "Chadda," which seems from their map to be the Benue. But if, as is possible, the "Fauces Garamanticæ" of Ptolemy are the Ahaggar massif, the Gir might very well be the wadi now known in its upper course as the Wadi Gir. This identification, however, is rejected by Bunbury ('Hist. of Ancient Geography,' 2, p. 628), though he agrees it was probably a river flowing from the south-east slopes of the Atlas Mountains.—ED. *G.J.*


Map to illustrate the paper on
ALEXANDER'S CAMPAIGN
on the
INDIAN NORTH-WEST FRONTIER
by
SIR AUREL STEIN, K.C.I.E.
Scale: 1/500,000.
5 0 5 10
Miles.
Heights in feet
Scale: 1/5,000,000
50 0 50
Miles
Area of Map
AFGHANISTAN
HINDUKUSH
KAFIRISTAN
Chitral
Gilgit
Indus
Indus Kohistan
KASHMIR
Torwalo
Upper Swat
DIR
Una-sar
Chakdara
Bajaur
Hindurāj Range
Malakand
MOHMAND
BUNER
Baffa
Mansehra
Amb
Mahaban
Jalalabad
Charsadda
Peshawar
Attock
Rawalpindi
ATTOCK
JHELUM
Jhelum
PUNJAB
N.W. FRONTIER PROVINCE
HAZARA
Walar Lake
14969
9954
Paital
7129
7942
35
UPPER
SWAT
Khwaja-khila
9490
8306
Charbagh
6855
Manglawar
3450
Mingawra
3176
Shamelai P.
Udegram
Saidu
45
Wuch
5003
Raja Guru's Castle
8460
LOWER
SWAT
Chakdara
Bir-kot
Landakai
Ambuk-darra
Thana
2563
Allahdand
Mt. Ilam
9250
Ilam P.
Lagarpur
Rajgalai P.


This map is based on the survey of Torubaz Khan, of the Survey of India, under the direction of Sir Aurel Stein, 1926, combined with earlier surveys
73°
45'
30'
15'
35°
45'
Gilgit
Kalam
Koshujan Pk
18750
17987
17621
Chodgram
Mankial
15380
Rainat
16230
11422
Torwal
Bruniat
9954
Ain
13182
Yakh-kandao
12482
14970
Churria
7122
13416
Paitat
7129
Ganshal
Derai
11267
Bilkanai
10821
8798
Shalka-kandao
Damorai
Karorai-kandao
7623
Ghorband
Kana
Khwaja-kila
Kuz-kana
Karorai
Shang
4807
Upal
Kuz-batkul
(Aarnos)
Pir-sar
3546
Una-sar
8721
7804
Upal-kandao
8360
Acharo-sar
Chakesar
Gunangar
Thakot
Mairu
Sarkul
9720
2460
Aloch
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B U N E R
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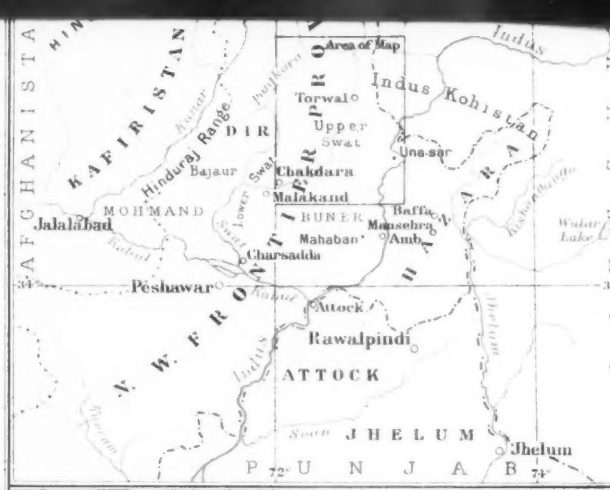
Puran
Black Mount
9797
Rajgalai P.
7810
Kabalgram
6332
7150



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Scale: 1/500,000.

5 0 5 10

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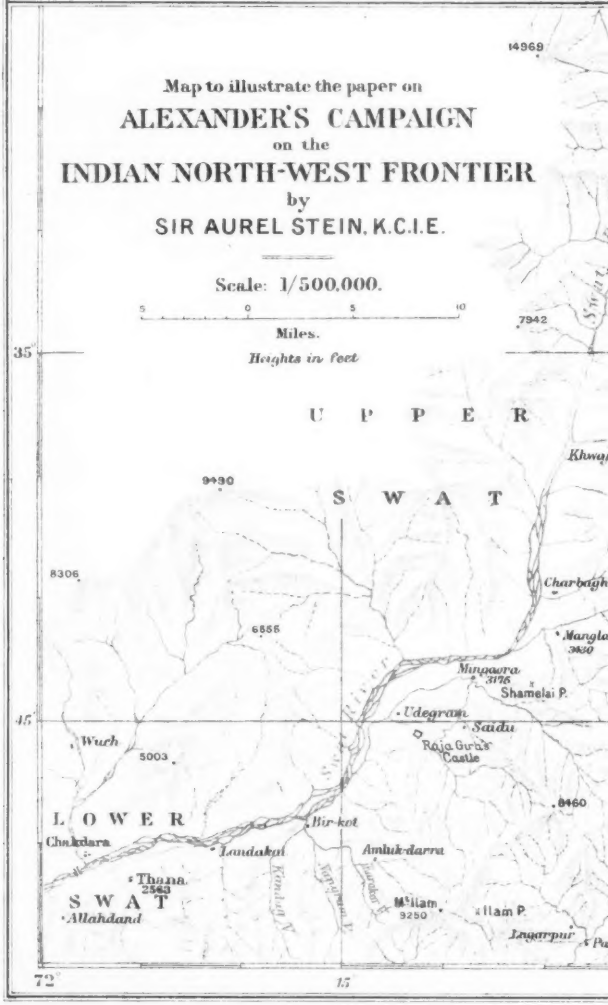
Heights in feet



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